olume XXXII ~ Number Two Summer 1953

# Bell Telephone MAGAZINE

*The First Five Years of the Transistor* • MERVIN J. KELLY

*Keeping the Radio Relay Network in Good Order*
MARION R. HESSIN

*Benefits and Pensions Have Proved Value for 40 Years*
EUGENE J. MCNEELY and CHARLES J. SCHAEFER, JR.

*"The Service in Toledo Did Not Break Down"*
JOHN H. PAGE

*Bell System Employment for College Graduates*
DONALD S. BRIDGMAN

merican Telephone & Telegraph Company · New York

# Bell Telephone Magazine

## *Summer* 1953


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*A Medium of Suggestion & A Record of Progress*


JUDSON S. BRADLEY, *Editor.* *Published four times a year for the supervisory forces of the Bell System by the Public Relations Department of the*
AMERICAN TELEPHONE AND TELEGRAPH CO., *195 Broadway, New York 7, N. Y.*
CLEO F. CRAIG, *President;* S. WHITNEY LANDON, *Sec.;* ALEXANDER L. STOTT, *Treas.*

# Who's Who & What's What

## *in This Issue*

In 1918, Mervin J. Kelley joined the research division of the Engineering Department of Western Electric, predecessor of Bell Laboratories. Assignments as director of vacuum tube development and as development director of transmission instruments and electronics preceded his appointment in 1936 as director of research. He became executive vice president in 1944 and, in the spring of 1951, President of the Laboratories.

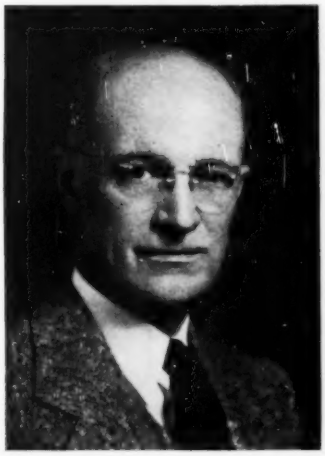
Dr. Kelly has had wide experience not only in the research and development of telephone equipment, but also in projects for the Armed Forces. In the course of World War II, the Laboratories converted almost completely to military research and development programs, all of which were under Dr. Keily's guidance. In recognition of his World War II contributions, he received the Presidential Certificate of Merit. In 1949 he accepted an assignment with the Atomic Energy Commission to make a critical analysis of the atomic missile research, development, and production program, and to recommend changes in organization to make it more effective. Out of this study came the Sandia Corporation. Dr. Kelly also serves as chairman of a temporary committee to advise the Secretary of Defense on certain aspects of the defense of North America, and he has acted as adviser to a number of governmental agencies on technological and scientific matters.

Dr. Kelly holds an honorary Doctorate of Engineering from the Missouri School of Mines and Metallurgy, his alma mater, and an honorary Doctor of Science degree from the University of Kentucky. He is a Fellow of the American Physical Society, the Acoustical Society of America, the Institute of Radio Engineers, and the American Institute of Electrical Engineers, and a member of the American Philosophical Society, the National Academy of Sci-

*Mervin J. Kelly*

*Marion R. Hessin*

*Eugene J. McNeely*



*Charles J. Schaefer, Jr.*

*John H. Page*

*Donald S. Bridgman*

ences, and several honorary fraternities. He contributed the authoritative paper "Radar and Bell Laboratories" to this MAGAZINE for Winter 1945–46.

SAVE FOR a couple of years' absence during World War II, MARION R. HESSIN has been a member of the Long Lines Plant Department since 1928. Starting as a transmission man in Springfield, Ohio, he held posts in various cities in that State until 1946, when he transferred to New York as a staff supervisor. He was appointed successively supervisor of equipment maintenance and inside plant maintenance supervisor, and he is now supervisor of equipment methods. These responsibilities have given him an intimate acquaintance with most of the Bell System's radio relay installations and the methods and equipment which keep the radio relay network in good order.

IN THREE DECADES EUGENE J. MCNEELY progressed from student engineer with the Southwestern Bell Telephone Company to A. T. & T. Vice President. Starting with the former company in 1922, he held various craft and engineering jobs leading through posts of increasing responsibility to that of district plant superintendent in 1932, division plant superintendent in 1935, and general plant personnel supervisor in 1941. He became Area plant superintendent in 1944, and general plant manager of the Company in 1948. In that same year he moved to New York as an assistant vice president in the A. T. &. T. Personnel Relations Department. In January 1949 he was elected Vice President (Operations) of the Northwestern Bell Telephone Company, and in December of that year he was elected President of the Company. Since September 1952 he has been Vice President in charge of the Personnel Relations Department of the A. T. & T. Company.

JOINING THE Bell Telephone Company of Pennsylvania in 1914, CHARLES J. SCHAEFER JR. gained experience in both Traffic and Commercial Departments before he was appointed a special assistant in the Personnel and Public Relations Department there. In 1925 he transferred to the Personnel Relations Department of the A. T. & T. Company in New York, where he is Secretary of the Employees' Benefit Committee. The present is his third discussion of the Benefit Plan in this MAGAZINE; five years ago he contributed "The Benefit and Pension Plan Is Thirty-Five," and the BELL TELEPHONE QUAR-

(*Continued on page 124*)

*Except during the short summer season, the last quarter mile of the approach to the Mt. Rose radio relay station is by aerial tramway. Note the "sno-cats" at the lower right approaching the ramp and shelter over 10 feet of snow.* *See page 87*

*The Head of the Bell Laboratories, Where the Transistor Was Invented, Describes This Revolutionary Device and Some of Its Telephone and Other Applications*

# The First Five Years of The Transistor

*Mervin J. Kelly*

FIVE YEARS AGO, in June of 1948, the Bell Telephone Laboratories announced and demonstrated publicly a semiconductor amplifier invented by John Bardeen and Walter H. Brattain, and coined for it the name TRANSISTOR. Demonstrations were given of transistor amplifiers and oscillators functioning in telephone and television repeaters and in radio receivers.

It is interesting at this fifth anniversary to recall the words used at that time by Laboratories Vice-President Ralph Bown to tell about the invention. He said in part:

"The genesis of this device is an interesting story of fundamental research and I think I ought to begin at the beginning and give it to you in orderly sequence . . .

"Scientific research is coming more and more to be recognized as a group or teamwork job. This is true not only in industrial research but to a rapidly increasing degree in academic research. In spite of this fact, there continues to be plenty of opportunity for individual work. What we have to show you today represents a fine example of brilliant individual contributions growing out of basic research in an industrial group framework . . . A considerable number of people have been working hard on this matter to bring it to the stage you will see today. Physicists, chemists, metallurgists, engineers, laboratory and shop technicians, auxiliary and office personnel—yes, even executives have played a part.

"In our laboratory the semiconductor research work is carried on by a group under the immediate guidance of William Shockley, a well-known solid-state physicist. Shockley, while examining critically the prevailing theory of electrical conduction in semiconductors, predicted that it should be possible to control the

meager supply of movable electrons inside a semiconductor by influencing them with an electric field imposed from the outside without actually contacting the material. Realizing the practical implications of such a possibility, he devised some experiments to test his hypothesis, but was unable to secure positive results. The electrons seemed to get tangled up in the surface of the material and did not behave just as anticipated. This part of the problem was tackled on a theoretical basis by John Bardeen. Bardeen developed a theory of what happened at the surface which was able to explain satisfactorily many of the observed facts and which led to further experiments carried out in collaboration with Walter Brattain.

"In the course of these experiments, Bardeen and Brattain invented the device we shall show you today. We have called it the TRANSISTOR because it is a resistor or semiconductor device which can amplify electrical signals as they are transferred through it from input to output terminals."

The announcement received little public notice—one of the most restrained send-offs in recent memory, according to *Fortune* magazine—but its importance was quickly recognized by the electronics industry. It has taken nearly five years for the transistor to reach a point of development and of general recognition commensurate with its initial promise. In that time the family of transistors has grown. Other types than that first demonstrated have been invented and developed for manufacture, and the word transistor has become a generic term for semiconductor amplifiers. The transistor invented by Bardeen and Brattain we now call a "point-contact transistor." It was the only transistor to reach practical application outside the Laboratories for nearly two years.

The point-contact transistor is by now quite well known. It consists of a very small piece of germanium with two fine wires contacting its surface, separated from each other but a few thousandths of an inch. The flow of current in one of the fine points controls the flow of current in the other, somewhat as the grid in a conventional vacuum (radio) tube controls the flow of current through the tube. But here the analogy ends. The transistor is solid, there is no vacuum to maintain. It is "cold," there is no need for a heater to supply electrons. Because of this it requires very little power to be ready to operate and very little power to operate, for it is efficient. It is small and rugged. It will almost certainly have long life in service. And we are finding many ways for it to be of service.

## *Early Uses of the Transistor*

A GREAT MAJORITY of conventional vacuum tubes are used to control or amplify small currents: in communication systems, in radio and television sets, in complicated military equipments such as radar bomb sights and computers. In such applications the transistor can be used. It does not replace the vacuum tube in the same socket and the same circuit. But with its own circuits it does the same jobs.

The point-contact transistor has been used in oscillators from very low frequencies to the very high frequencies of short-wave radio. It has been

*With this apparatus some of the first investigations leading to the discovery of the transistor were made. Standing are John Bardeen (left) and Walter H. Brattain, inventors of the point-contact transistor. Seated is William Shockley, who directed the Laboratories research program in semiconductors*

used over this wide frequency range to amplify and to control electrical signals. And it has been used, together with other very small components, to make a variety of compact electronic "packages" which perform a great many of the functions required in the modern electronic art.

With its virtues there are also some limitations: the point-contact transistor is more "noisy" in a circuit than one would like, and its ability to handle power is limited. The "noise" tends to restrict its use to the control of electrical signals rather than their generation or amplification and its power capacity limits it to relatively small currents.

The point-contact transistor, first member of the family, has been joined by a number of other types which have been announced during the five years under review. A "photo-transistor" invented by J. N. Shive has already gone into Bell System service in the "card translator" used in telephone exchanges for automatic routing in toll dialing. The photo-transistor is a device in which the flow of current through a point-contact on a

*A portion of the "cartridge" casing of a point-contact transistor has been cut away to show, magnified, the two points on the germanium surface*

small germanium wafer is controlled by a fine beam of light shining on a sensitive area of the germanium surface. In its telephone exchange use it conserves both space and power.

## *The Junction Transistor*

EARLY IN THE STUDY of transistors, it was predicted by Shockley, on the basis of theory, that a "junction" transistor, different in structure, would have useful properties. The idea was to have in a germanium crystal a very thin region of one electrical type separating the two adjoining end regions of different electrical type. The two boundaries or "junctions" between the thin region and the two end regions were to serve the same functions as the two points in the point-contact device. The thing itself was simple. Shockley's theory could predict the performance to be expected. The problem was to find ways to make it.

With metallurgists and chemists and physicists working together, such units were made. A thin layer with the necessary electrical property was produced in a germanium crystal without destroying the otherwise essentially perfect regularity of the crystal. Junction transistors produced in this way not only behave as the theory says they should; they have other remarkable properties as well. They are not "noisy." In fact, they compete favorably in respect to "noise" with the very best vacuum tubes. They are remarkably efficient, closely approaching the maximum possible. But perhaps most interesting, they are ready to operate with as little as one-millionth the power necessary to keep an ordinary vacuum tube, with its hot cathode, in the ready condition.

For telephone uses the significance of this extremely low power drain is not hard to see. The sound power in a telephone receiver for normal conversation is comparable to the power needed by the transistor to keep it in working readiness. Conventional vacuum tubes, requiring many, many times this standby power, are used of course for special needs and in all long distance circuits where many conversations may be amplified at the same time. But they are economically unjustified in the local telephone plant or in the telephone instrument itself. With the junction transistor this is no longer the case: its minute power requirements remove that economic

limitation and make it available for extensive telephone use.

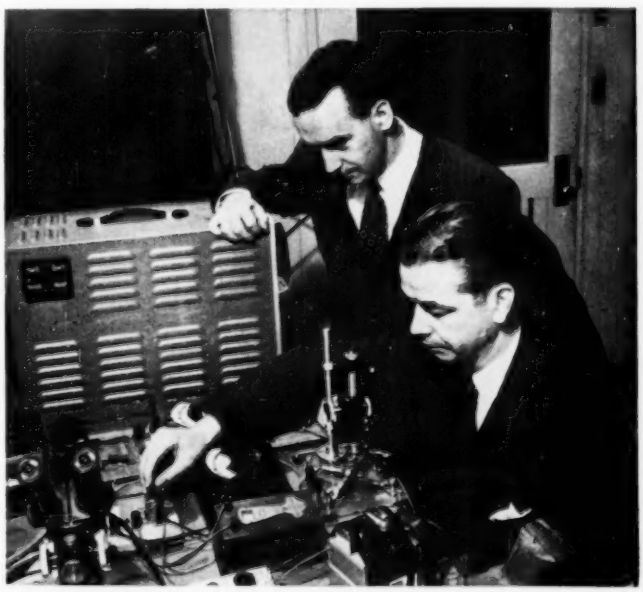
### *"Single Crystals" of a Very Pure Material*

WE HAVE passed over lightly a matter of major importance in the history of all transistors: the "single" crystal and the extreme purity required of transistor materials. The earliest transistors were made of germanium purified and allowed to solidify by conventional metallurgical and chemical techniques. The germanium usually solidified from the molten condition as a random collection of smaller crystals. Transistors from this polycrystalline germanium showed erratic performance from one unit to the next. The problem was to get the germanium into one big "perfect crystal." Our chemists and metallurgists did this. In fact, they have found several ways to make "single" crystals. This source of difficulty is now well past—all transistors are now made of "single crystal" germanium in which the successive layers of atoms are carefully ordered, one upon the other.

The question of purity has also been vital. Transistor action depends on the presence in the germanium crystal of a very few "foreign" atoms—perhaps one foreign atom for each 100,000,000 germanium atoms—and their arrangement in the crystal must be controlled. This means that we must purify the germanium to an even higher degree of purity—then introduce the known and carefully controlled "impurity" where we want it. The germanium so prepared may very well be the purest material in existence.

### *Some Telephone Uses*

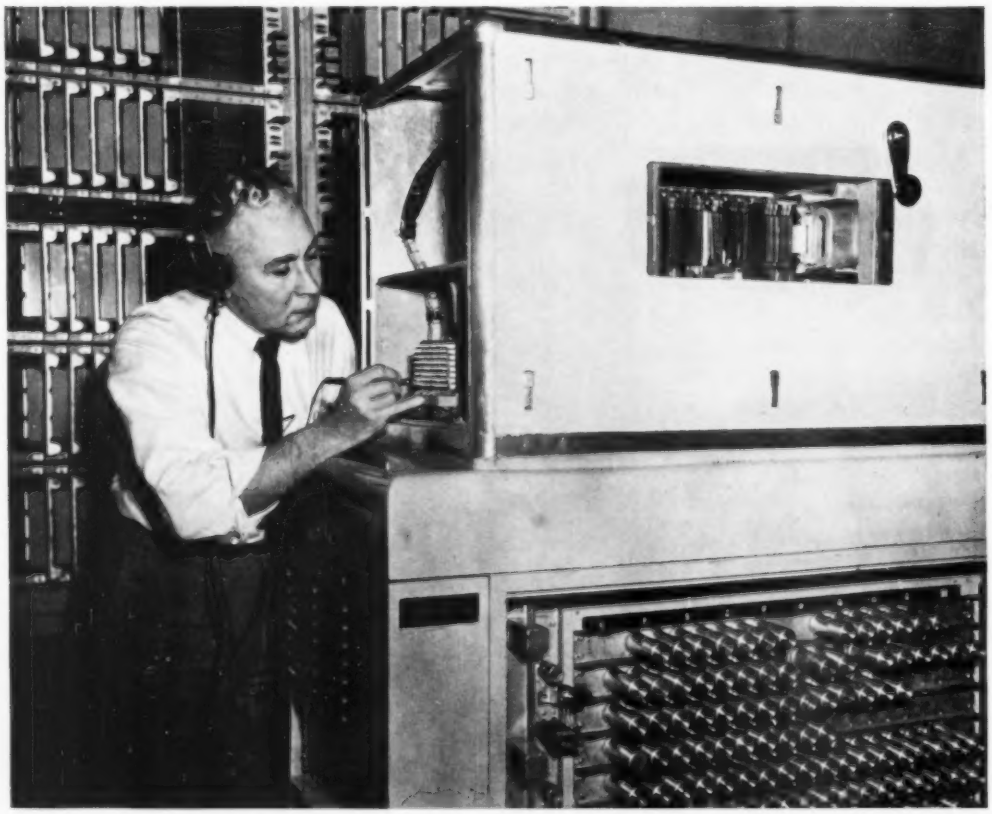
IN THE LABORATORIES many possibilities are now being explored. Will telephone instruments of the future use transistors directly? Very likely, and there is active work in progress. Will transistors be used in the complicated exchanges where the telephone user is automatically connected to the party he is calling? Very likely, and very promising. Promising in terms of what can be done, speed of operation, power and space



*The ease with which electrons move in a semiconductor crystal is an important fundamental measurement here being performed by Gerald L. Pearson (standing) and J. R. Haynes*

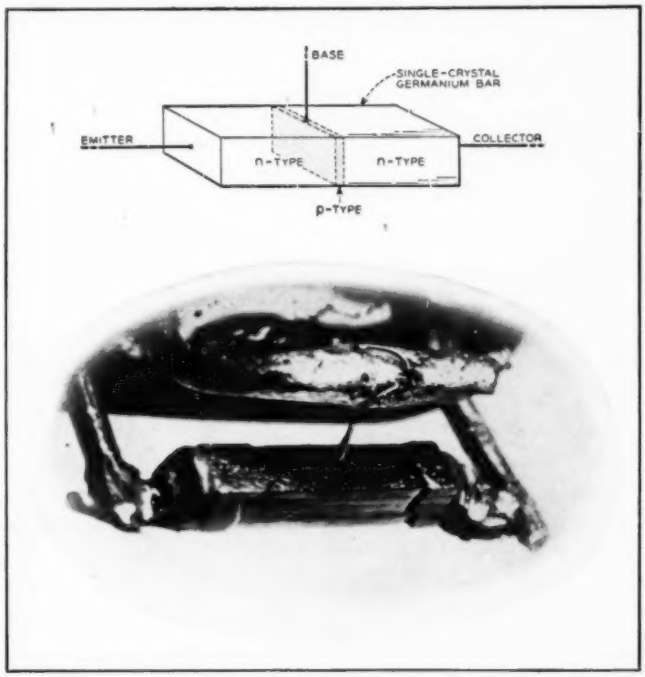
needed, as well as probable cost and reliability in service. In our automatic telephone exchanges today there are substantially no operators. But even with mechanization, electronics has had only a small part to play in the evolution of complex switching systems such as No. 4 and No. 5 crossbar. Transistors, as well as other solid-state devices, with their capability of high speed operation, their small bulk and low power requirements, will find natural application in switching apparatus.

Will the transistor have a role to play in distributing television pictures in communities or improving long distance communication? It will have a role to play in both. It may well be that broadband circuits for long distance uses will take new form through lower circuit mile costs that the transistor will make possible. New opportunities for extensive distribution of television in urban areas are possible. The transistor may allow the use of our carrier methods over shorter distances and lightly loaded lines. Its use in exchange areas and on rural lines cannot be excluded. A recently announced Laboratories development, the "tetrode" transistor of R. L.



*The first commercial application of the transistor and the phototransistor was in this card translator equipment. The card translator was initially installed in 1952 as an adjunct to the complex telephone switching system used in nation-wide operator toll dialing*

Wallace, Jr., is an important step.




*In this magnified view, the fine wire on the top surface of an experimental junction transistor is seen connected to a thin central section of the germanium bar. The germanium crystal itself is continuous but the electrical properties of the two end portions differ from those of the central section*

## *The Tetrode Transistor*

AN INITIAL LIMITATION of the junction transistor lay in its inability to handle the higher frequencies. This limitation for many uses is now largely removed by the invention of the tetrode transistor, which, however, retains the other virtues of its predecessor. We cannot foresee all of its ultimate uses, but already it has been used in a high-performance amplifier of minute dimensions. The entire amplifier is housed in a tiny "coaxial cable" about one-eighth inch in diameter and one and a half inches long. It requires no more power than its small size suggests, and it can readily satisfy the severe requirements of television transmission.

Research, invention, development, and application have grown at a hearty pace. But the field is still very new, and as the studies progress and understanding increases so also does the prospect. Before the first announcement, five years ago, when the new physical phenomena were observed and radically new electronic devices invented, it was evident to us that we were seeing the beginnings of an era in electronics technology—of significance not only to the telephone system but also to the military services and to industry and civilian use generally.

How did we open the door to this new era?

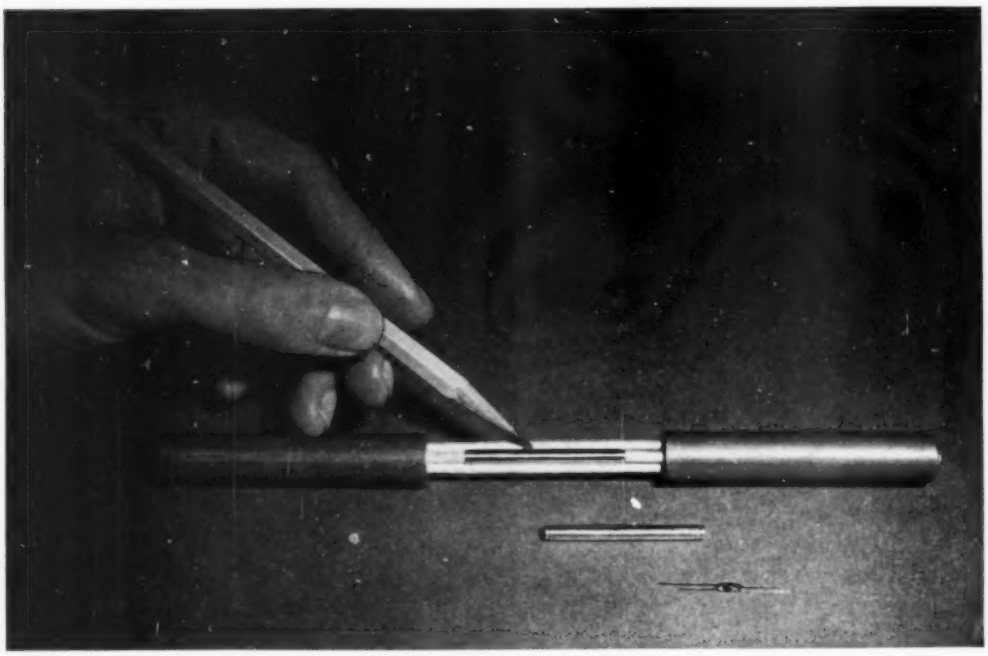
## *Organized Creative Technology*

I HAVE HAD OCCASION before to stress the value of continuity in the procedures from the initial steps of forward-looking basic research to the terminal operations of manufacture and use. I speak of them as the single entity: "organized creative technology." No example illustrates its meaning more dramatically than the story of the transistor.

I have already emphasized the

comprehensive work of the research group in studying the mechanisms of conduction of electricity in solid semiconductors. Physicists, both experimenters and theorists, metallurgists, chemists—were joined together in a common effort to gain understanding in a field of relevance and potential importance to communication technology. The scientists published the results of their findings and frankly discussed the new phenomena with their peers.

In accord with our policy of concentrating the efforts of our research scientists on research, we immediately formed a fundamental development group under J. A. Morton. This group was closely associated with research to acquire that body of technological knowledge essential to the development and design of transistors for the many specific communications applications that would certainly follow. The fundamental development group was composed of men of electronics, skilled in the development of new electronic devices for communication and military uses. In the beginning, their interests and activities were not distinguishable from those of the research group. Their first task was to learn, and this was quickly done. However, their ultimate role was never in question. They were to apply the new knowledge from research and to supplement it—in a more specific way—to create new devices for our systems development groups to utilize in creating new systems both for the Bell System and for the military services that would find application because of economic or fundamental advantages.

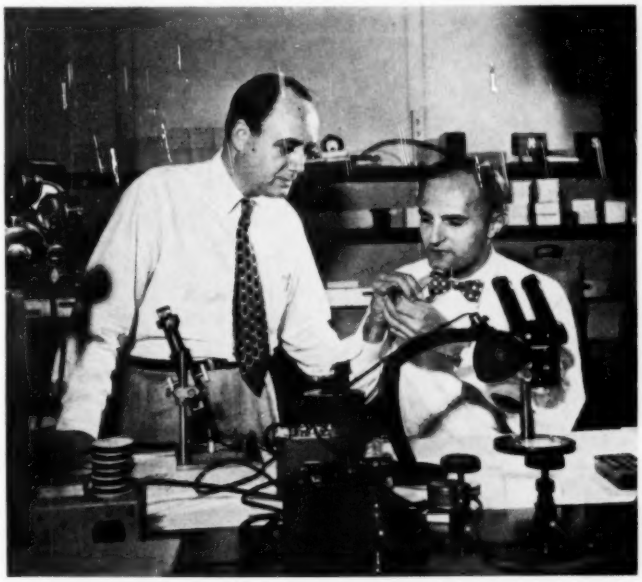


*In the foreground is a "tetrode" transistor. The small cylinder houses a complete amplifier. Shown also is the amplifier in place in a possible cable*

Contributions to new knowledge were made and, as applications of transistors became more and more clear, the group turned its attentions to the development of specific designs which would be required on a large scale. They have also interested themselves in such problems as the factors controlling the band width of amplification, the "noise figure," the amount of amplification possible per stage, basic materials, processing, and structure studies essential for controlled development and design of transistors for a variety of specific functions.

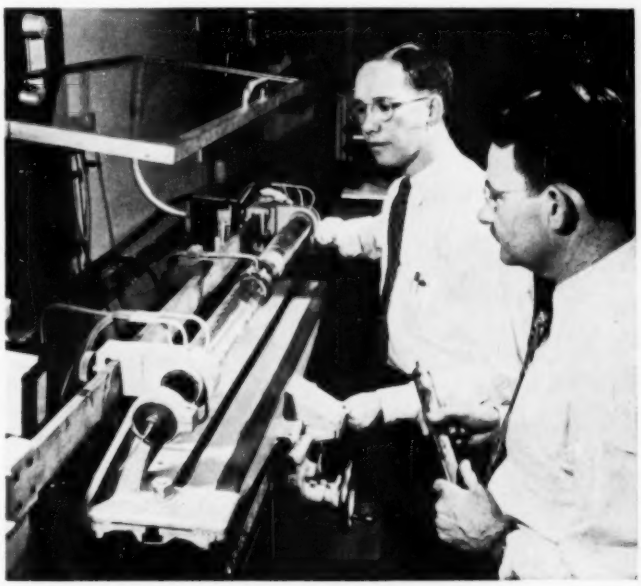
The link with research was strong and stimulating. A linkage with the systems development people, the likely users, was also encouraged. Jointly with the user, operating characteristics of transistors were established, units were constructed for trial, and pre-production methods were worked out.

Following the pattern used for electron tubes, the final stages of design for manufacture are carried out by the Laboratories group located at the Western



*Above: The making of composite crystals for junction transistors was a problem for chemists. Gordon K. Teal (left) and Morgan Sparks are here studying one of the early units*

*Below: Ingenious new metallurgical techniques have played an important part in the purification of germanium. Using the "zone refining" method here being demonstrated by its inventor W. G. Pfann, germanium of extreme purity is produced. J. H. Scaff is holding a large germanium "single crystal" made by this process.*



*Above: When the feasibility of a new device has been demonstrated, its development is taken over by an Apparatus Development department. J. R. Wilson (right) and J. A. Morton head the Electronics Apparatus Development Department which has brought the transistor to its present state. Below: The tetrode transistor is now a joint undertaking between research, R. L. Wallace, Jr. (left), and development, W. J. Pietenpol*

Electric Company factory at Allentown, Pennsylvania. Because of the novel processes and technology used in making transistors, Western Electric sent its engineers at an early stage into laboratories work both at Murray Hill and at Allentown. Twelve different transistor types have so far been through this development sequence and have been put into pilot plant production by Western at Allentown. Meanwhile, Western has made ready at Laureldale, Pennsylvania, a production plant for military transistor manufacture. Tens of thousands of transistors of all types have been produced by Western and supplied not only for Bell System and military uses but also to various other developers and manufacturers of military equipment.

The course of development is one we well know: severe requirements to meet high standards, unsuspected difficulties, failures—and success. The pattern continues, and in taking stock we can say that while there are probably as many problems ahead as have already been solved, tran-

sistors are built on an unusually firm scientific foundation; and they have been developed to a status of flexible utility, reproducibility, and reliability. They are now made of material of crystalline perfection and remarkable purity, produced through the ingenious processes of our chemists and metallurgists. Their service life in proper use we expect to be very long. They are "reproducible" in the same sense that vacuum tubes are reproducible and as the art of their manufacture matures, they should be inexpensive.

### *Apparatus Components for Use with Transistors*

A NEW DEVICE or a new invention stimulates and frequently demands other new devices and inventions for its proper use. This is particularly true of the transistor. Its circuit technology, its efficiency and low power requirements we have already mentioned. Operating voltages in most applications are remarkably low, perhaps $\frac{1}{20}$th the voltage required by ordinary vacuum tubes—only a fraction of the voltage readily available in telephone central offices.

*Here in the Western Electric Company Allentown Plant a battery of machines is in operation for cutting single crystals of germanium into very small units to be used in transistors*

At these low voltages, capacitors will be made and are now under development which are as much smaller than ordinary capacitors as the transistor itself is smaller than a vacuum tube. In telephone communication uses, with low voltages and low currents, coils and transformers may be correspondingly "miniaturized." A whole series of new miniature components is now being developed in the Laboratories for use with the transistor—to take full advantage of its modest requirements.

## *Military Uses*

BELL LABORATORIES ACTIVITY in transistors is primarily in two directions: to serve the needs of the Bell System and to contribute to the military strength of the country. It was recognized at the outset that secrecy would severely hamper both of these objectives by restricting the free and rapid flow of ideas and delaying broad use of the new technology in military applications. A policy was adopted to make transistor information easily available to those with a legitimate need for it. This policy has been implemented both through our usual practice of early publication of scientific work and through patent licenses offered by the Western Electric Company.

To expedite the availability of information, there was held at the Murray Hill laboratory in September 1951, with the coöperation of the Military Services, a week-long symposium on the characteristics and applications of the transistor. Some 300 engineers from our own and Western European countries attended. Thirty-five papers by members of our staff were presented, and later issued as an 800 page volume.

*Silicon, another important semiconductor, is purified and grown in "single crystal" form in this apparatus by E. Buehler*

In April of 1952, a symposium on transistor technology—devoted to the dissemination of "know how"—for licensees of the Western Electric Company was held at Murray Hill and at the Western Electric Company plant in Allentown. Representatives from 26 domestic and 14 foreign organizations attended intensive sessions lasting eight days. The material presented, cov-

ering the entire range of technology, was subsequently published as a two-volume classified work. Later still, in the summer of 1952, a short course for university professors was held, attended by professors from over thirty institutions. The result has been widespread development both in university research and in the industry.

*The "photo-transistor," "point-contact," "junction" and other transistors for special Bell System and military uses are responsibilities of development engineers A. E. Anderson (left), J. N. Shive (center) and R. M. Ryder*

Specific military applications of the transistor must, of course, remain classified, but an appreciation of its promise in military use can still be had, as the following example shows. In World War II, radar played a very important part. Today, aircraft bomb sights are built around radar. Detection of targets, range, and bearing all come from radar. This information feeds into a "computer" which quickly determines the proper release point, taking into account other information as well: aircraft and wind velocity, altitude, and the flight characteristics of the missile. The radar and computer make a highly intricate electronic system, using hundreds of vacuum tubes and considerable power, and occupying much valuable space. Perhaps 80 per cent of the vacuum tube functions may equally well be performed by transistors, with savings in space, weight, and power alone of major significance to our air forces.

In many other parts of our complex military technology there are uses, large and small, for transistors. Reliability, small size and weight, low power consumption—these are goals of the designers of military equipment. The transistor takes us a large step towards these goals.

## *Future Developments*

TODAY'S ELECTRONICS INDUSTRY is built largely on an invention of Lee deForest in 1907: the three-element vacuum tube. The first commercial use of the vacuum tube in transcontinental telephony was in 1915, eight years later. The vacuum tube had extensive development for military purposes in World War I, and was used in telephone carrier in 1918.

The transistor is very young and already it is making its mark. Its impact will be felt not only in replacement of vacuum tubes for reasons of

*Miniature apparatus components have been developed to work with the transistor. The transistor itself is small compared to the smallest vacuum tubes. Resistors, capacitors, transformers, inductors are all correspondingly smaller than their counterparts used with vacuum tubes*

economy. It will make completely new fields for itself as it begins to do work where vacuum tubes have so far been excluded. Ultimately we shall see transistors at work automatically routing and connecting telephone calls through exchanges, doing accounting and computing, and performing in other so-called "electronic brains." They are now appearing in hearing aids, and we shall soon see them in home radio and television sets.

The transistor, with all its promise, will come into large-scale use in the Bell System only gradually. Other fields of application—military electronic systems, home entertainment, special services—may well have the larger initial uses. For in these fields, particularly the military, it will now be possible to do things, urgent things, with transistors which have heretofore been prohibited by the size, weight, power requirements, or lack of reliability of alternative methods.

This is not the case in most telephone applications. The Bell System plant is a carefully integrated complex of instruments, transmission paths, and interconnecting mechanisms which has been evolved over the years to provide service at low cost and with great reliability. The transistor will emerge as an important part of our telephone technology only as rapidly as we gain sound experience with its practical ability to meet the requirements of the present system. New services and new methods of providing present services are being examined continuously from a systems standpoint. The transistor gives us a powerful new tool in these studies.

A new technology is growing around the transistor; a new industry will grow with it. Bell Laboratories, continuing in the forefront, will realize for the Bell System and the military services the promise of these five years.

*New Methods Have Been Developed for Maintenance of 230 Radio Relay Stations, in Varied Locations throughout The Length and Breadth of This Country*

# Keeping the Radio Relay Network in Good Order

*Marion R. Hessin*

WERE YOU one of the many thousands who enjoyed the Rose Bowl football game as brought to you via television from Pasadena last January 1? Just about an hour before the start of the game, a vacuum tube failed in one of the Bell System's radio relay stations high in the mountains, and instantly broke the circuit which was to carry the game to television broadcasting stations throughout the country.

Despite the tube failure, you were able to watch the game because several things then happened in rapid succession. A light flashed on instantly in an alarm center in a telephone company building not many miles away, showing not only that something was wrong at that particular relay station but exactly *what* was wrong. A maintenance man was dispatched immediately by car to the station, where he replaced the tube—thus restoring the circuit to operation in ample time for the game.

This was the indicated course of action under those particular circumstances. Had other conditions prevailed, a different move would have followed: a quick shift to another radio relay circuit, for instance. Indeed, facilities are now being provided along the main radio relay routes for immediate automatic switching from one channel to another in case of need.

There was nothing spectacular about the incident—unless perhaps it was the mountain scenery. But it involved manpower, equipment, and skill—all of which the Bell System had provided in advance against such an occasional mishap.

This example is cited because, as the System's radio relay network grows, month by month, more Americans receive long distance telephone calls and more television broadcasting stations receive live programs from distant points by means of this new

communications medium. Already, there are some 230 radio relay points on these routes which crisscross the countryside for more than 8,000 miles. For if these calls and programs reach their destination in good shape, as indeed they do, it is evident that a new and sizeable maintenance task is being encountered—and accomplished.

Each radio relay station on this vast network is a small, independent unit, usually situated at some distance from the centers of normal telephone company activity. On the average, each station is some 30 miles from the neighboring relay stations to and from which television programs and hundreds of telephone conversations are transmitted via concentrated beams of radio energy. Both the radio equipment and the power plant in these stations are designed to be operated continuously and without personnel in attendance.

Here, then, is the maintenance problem: to insure the proper functioning of a certain amount of radio transmitting and receiving equipment, plus the power plant necessary for its operation—all to be found at some isolated spot on farmland, in forests, on the plains, on mountainsides, or even in the desert. Operate the station must, or the program and the message will not get through. Yet it is miles down the road—or along a telephone line—from the nearest center where telephone people are to be found. Nonetheless, as the reader knows, that call or program does get to its destination by radio relay.

## *Organization for Maintenance*

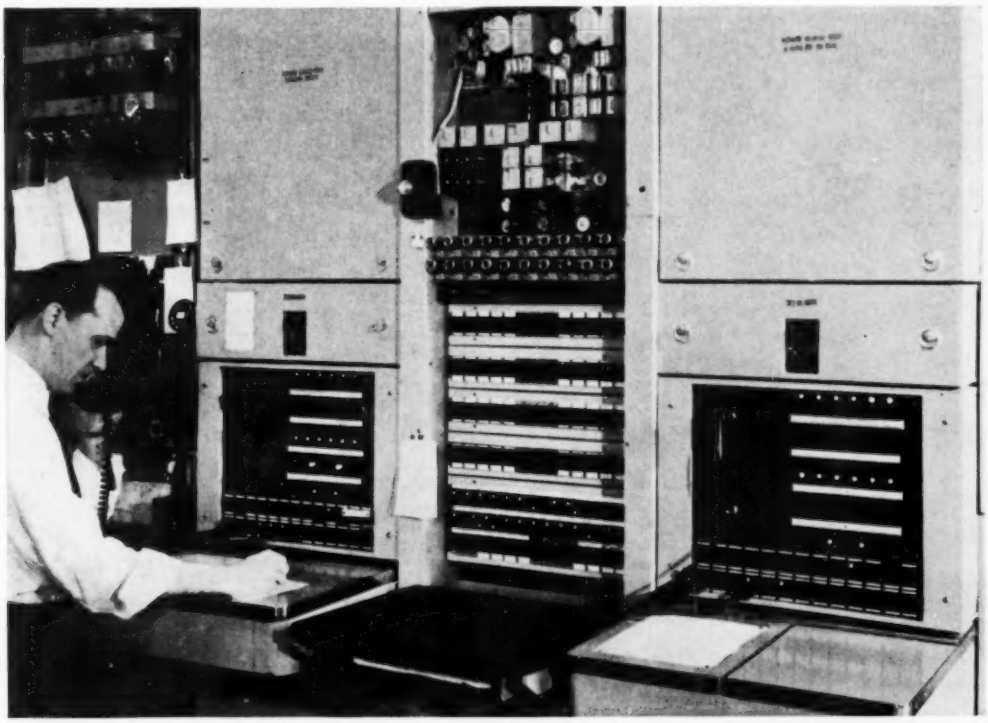
THE PROBLEM is handled this way: An established telephone office, where people are on duty day and night, is selected for its strategic location in relation to several—say, three to five—radio relay stations, and is desig-

nated as the maintenance center for those stations. In practice, this means that the maintenance center is within about 75 miles or a couple of hours' auto travel time of the relay stations assigned to it for observation. Where two radio routes cross, incidentally, it may even be possible to maintain as many as ten relay stations without increasing the travel time from the maintenance center to the most remote unit in the groups.

Each maintenance center is staffed with trained craftsmen, who carry out their responsibilities by means of periodic routine inspections at the relay station and by being on call in case of sudden trouble.

Now, each relay point may be unattended but it is not, so to speak, unprotected. A remarkable automatic alarm system is installed in each relay station which can register scores of different situations, indicating normal operation as well as some irregular condition. Thus, if a tube fails, commercial power is cut off, a relay balks, the station door is opened, or other difficulties arise, the alarm system will instantly flash news of the event to an "alarm center," where an ingenious arrangement of lights indicates the location and nature of the trouble.

Alarm centers are established in certain maintenance centers—usually one alarm center to each three of the latter. The alarm system is capable of handling the troubles reported by as many as 12 radio relay stations on the network.

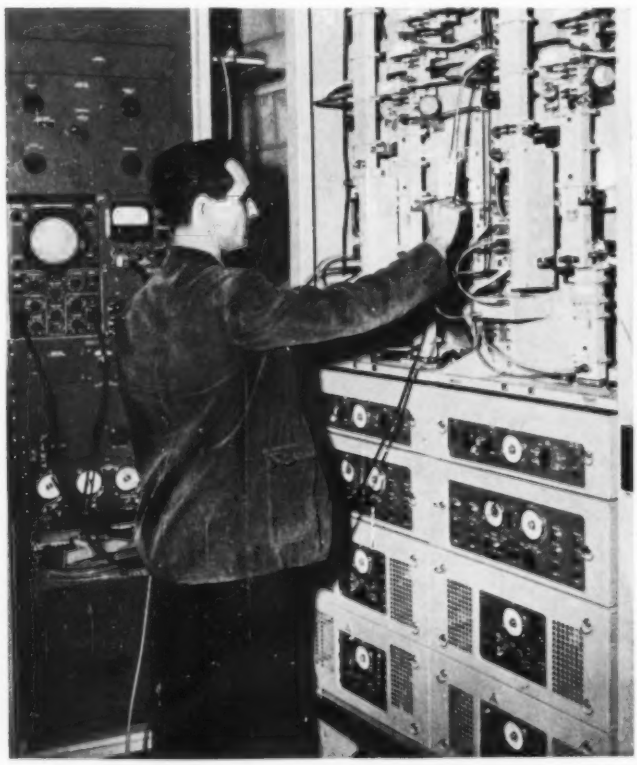


*Signal bays at an alarm center. Here a light flashes and a bell rings to notify an attendant of some irregularity at a radio relay station within his territory*

Actually, the alarm system is so arranged that it is possible for those at the alarm center, by throwing keys and pushing buttons, to perform by means of remote control any one of ninety different operations within the station sending the alarm. However, the alarm received may indicate a condition that only a maintenance man on the scene can solve. Under such circumstances, those at the alarm center will promptly get in touch with the force at the nearest maintenance center, which will dispatch a man to the point in difficulty. Meanwhile, alternative facilities will be handling whatever messages might have been subject to interruption.

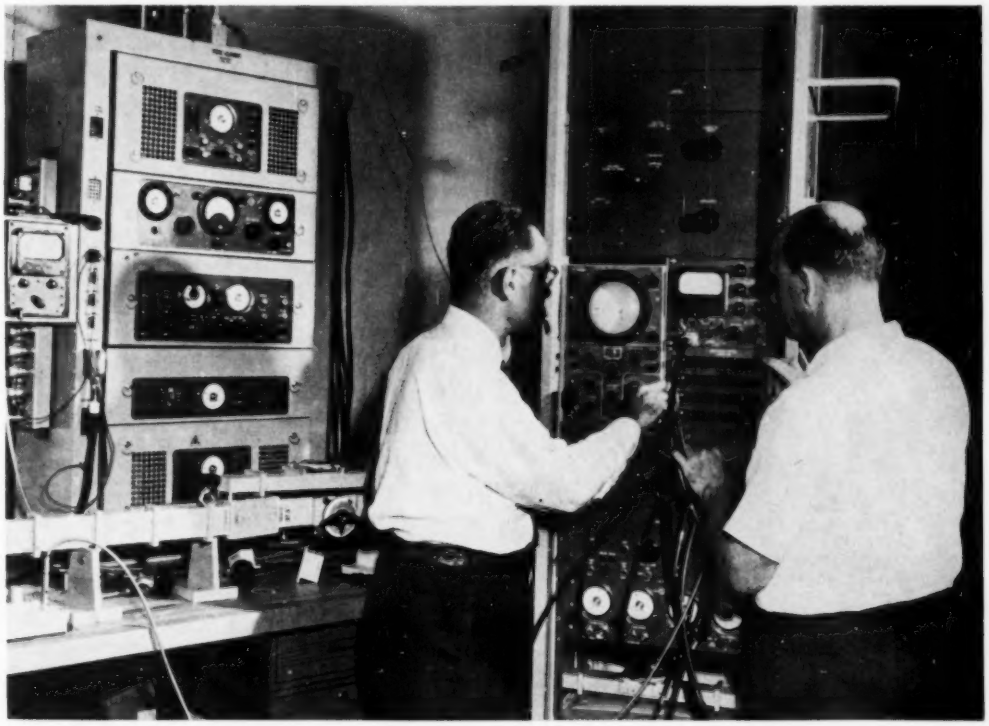
A further duty of those at the alarm center is to report such incidents to still another telephone company office—the "control office," which is responsible for the over-all continuity of the television program or telephone service. Such offices are found at a few widely separated key cities where various radio relay routes come together, and have the responsibility of directing circuit rearrangements or rerouting if the interruption cannot be remedied quickly at the relay station itself.

At each relay station a certain amount of testing apparatus is available and, as a result, a high percentage of both preventive and repair work can be handled on the spot. Some troubles can be cleared by the replacement of, say, a single tube, but others may require the replacement of an entire sub-assembly of equipment. Consequently, spare parts and sub-assemblies of apparatus for such replacement are kept at each relay station. These can usually be installed in about fifteen minutes after a maintenance man has reached the relay station. Defective pieces of equipment which have been removed from service are returned to the maintenance center, where the necessary apparatus for repair and adjustment is available.



*This man is using testing equipment to adjust equipment in a radio relay station*

Some of the radio re-



*Equipment men in a maintenance center are testing a radio amplifier*

lay stations are so remote that no commercial electric power is available to them. Then maintenance includes responsibility for continuous operation of the primary power plant as well as the emergency generator.

There are, too, the unusual problems involved, for example, in maintaining equipment often installed on a temporary basis, for establishment of a microwave link to handle some special event or in order to hurry network television into an area which is eager to see "live" programs from afar. News stories about these matters are full of the excitement and value of the occasion. But it is clear that a radio relay station set up to handle a single football game, or a political speech—hence one which includes apparatus lined up under pressure and not equipped with as complete testing facilities as are ordinarily available at a regular point on the network—offers special maintenance problems. Nonetheless, when General Eisenhower launched his campaign by speaking from Abilene, the equipment was ready for him. And even if the trio of stations set up temporarily (pending a permanent installation) to speed network service from Oklahoma City to Tulsa were incomplete in some details, the equipment performed without fault.

Again, there are what might be termed normal maintenance difficulties. A score or more of radio relay stations, such as the very tall structure at Valparaiso, Indiana, house

*"Cabin in the sky": on the route between Omaha and Denver several of these towers support transmitting and receiving equipment about 100 feet above ground*

radio equipment and regular power plant half way up the tower. In the case cited, all apparatus must be hauled up by block and tackle, and the men occupied with maintenance must climb 100 feet by an inside stairway to the scene of their work.

And there are, of course, the really odd problems. The radio relay station on Suwanee Mountain, just north of Atlanta, for example, has intruded on the home of a flock of buzzards. The buzzards, it develops, are not happy with this invasion of science into their midst—but they are making the best of things by perching on the top of whatever radio antenna horns are available. Almost as many efforts to dislodge buzzards have been undertaken as were devoted some years ago to the problem of crows sitting on telephone wires. Physical efforts to dislodge them have left a good deal to be desired in effectiveness, and the most recent buzzard "shooer-awayer" is a sort of Rube Goldberg noise-maker.

### *Finding the Trouble*

WHEN THE PATTERN of lights in an alarm center indicates to the attendant that there is trouble at a radio relay station, he takes immediate action to determine the exact nature of the difficulty, and then alerts the maintenance center responsible for the station in trouble, so that remedial measures can be taken. When the alarm shows a transmission path failure, the maintenance center notifies the control office—in those cases where the automatic protective facilities fail to function for any reason—in order that service may be rerouted to another path.

Frequently the alarms show conditions which have not caused actual service failure but which may call for adjustment of the radio or power equipment to prevent a failure or to avoid adverse effect on the conversations or TV programs being transmitted. Above all, the maintenance of radio relay equipment involves the care of electronic tubes. Actually, about 85 per cent of the troubles experienced on this relatively new type of facility have related to tubes, and it is immediately apparent that the reliability of the radio relay service is largely dependent on the proper testing of those tubes.

A remarkable new tube, which made microwave radio relay operation possible, was developed by the Bell Laboratories, but its relatively short service life offered the maintenance forces real difficulty. Now, as

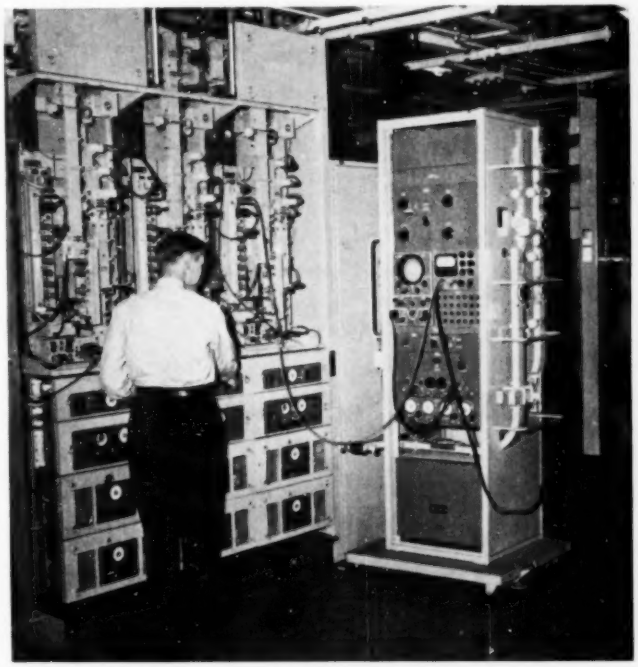
a result of continuing developmental work, the tube has been re-designed both mechanically and electrically, with the result that the newer model is far hardier—and there may even be some gains in transmission performance. Already, a program is under way through which, it is expected, all the old tubes will have been replaced in less than a year's time and, with the new tube in use, it is believed that failures will be reduced by more than 50 per cent.

When the maintenance man arrives at a relay station, he first gets in touch with the alarm center to be sure that the equipment in difficulty is idle and therefore is available for test. In clearing a case of trouble, a series of meters can be connected rather quickly to strategic points in the radio equipment. This permits the maintenance man to ascertain the condition of the numerous tubes as well as the condition of other parts of the apparatus. Perhaps a vacuum tube substitution may put the unit back into working order. Or if a condensor or a resistor has failed, it becomes necessary to substitute one of the spare pieces of apparatus available in the station for just such an emergency. Once the replacement of tube or unit has been made, the entire radio apparatus must be checked to determine that the equipment is able to transmit a television program or telephone conversation of satisfactory quality. Finally, when the trouble has been cleared, the maintenance man notifies the alarm center and the control office that all is well. And then he returns to the maintenance center.

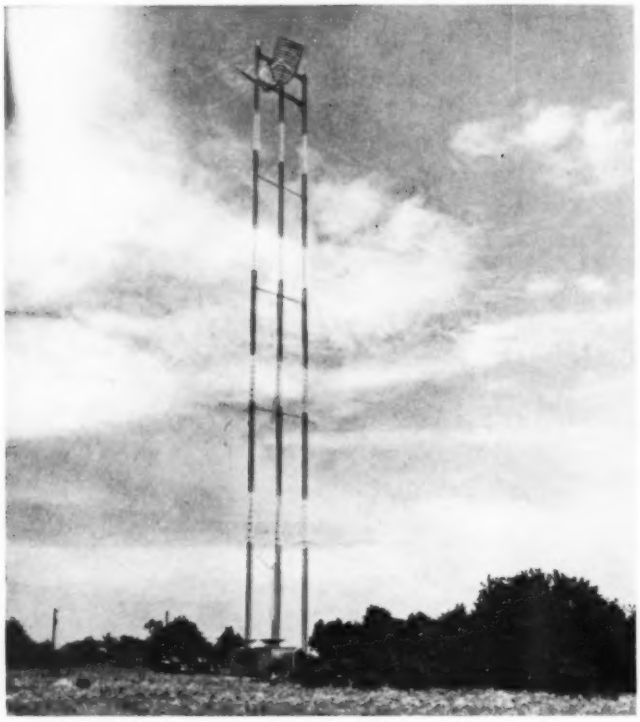
### *On Location*

The actual trouble clear-up episode doesn't always turn out so neatly, for Mother Nature sometimes takes a part in it.

Being located throughout this country, radio relay stations are found in all imaginable types of terrain. A unit of the Bell System network which is in difficulty may be perched on a hill-top in Pennsylvania, sitting on the salt flats in Utah, or overlooking the Golden Gate in San Francisco. Maintenance men must be equipped to reach all these points at every season



*End of the line: adjusting a channel at a terminal in New York City*



*A semi-permanent antenna support. The bowl-shaped objects on the roof of the building beneath the uprights are "dish" antennas, the rectangular objects at the top are metallic "mirrors," and the signals—conversations or television program—are "bounced" between the two en route to and from the adjoining towers of the radio relay system*

and at any hour, sometimes by driving along all-weather highways, and on occasion over the more difficult access roads leading to stations which may be situated at points remote from more traveled roads.

Ordinarily a passenger car does the trick, but in the mountains and over rougher terrain at the season of mud and snow a four-wheel-drive jeep offers many advantages. When stations at inaccessible spots are to be reached at the time deep snow makes both highway and approach roads impassable, specially designed vehicles, called Sno-cat and Sno-shu, are used. These vehicles utilize caterpillar tread, so that the maintenance man finds it possible to travel over snow.

The writer recalls one such occasion when he and several companions bent on observing conditions at radio relay stations left the maintenance center at Elko, Nevada, on a cold overcast day, with a couple of feet of snow under foot. The overcast sky kept the light intensity very low and the horizon seemed to melt into the sky. Nonetheless, the going was fairly easy for a few miles. Then an "overhang" of snow close by our trail caused us some concern lest we drive the Sno-cat out on to such a snow formation and break through for a long fall. In some places it was necessary for one man to walk ahead of the Sno-cat on snowshoes to be certain that there was solid mountain to drive on. Elsewhere, the side hill became too steep because of fallen or drifted snow, and it was necessary to shovel out the high side to prevent the "cat" from rolling over.

The trip to the radio relay station atop Mt. Rose, Nevada, is beautiful but long and sometimes very rough. Probably it is the toughest travel problem for radio relay maintenance. On a trip there last year, some men were driving the Sno-cat over 20 feet

of snow in front of a ski lodge when a woman called, "Would you please move that thing? It's sitting on top of my convertible." She had parked her car there before the snow fell, and by this time it was covered by several feet of snow. (The car was eventually dug out and was none the worse for its cold storage.) An aerial tramway over the last 1400 feet provides winter access to the Mt. Rose station.

Experience has shown that it is possible to be caught in a snowstorm after reaching some stations and an immediate return to the maintenance center rendered out of the question. So, some of the comforts of home are provided in a number of the most inaccessible relay stations to make possible a stay of three or four days. In one station, located on a mountain top, there is an electric stove, a deep freeze, a bathroom, and plenty of magazines.

Interestingly, the Mt. Diablo radio relay station—the first auxiliary station south of San Francisco on the San Francisco-Los Angeles route—is in the Mt. Diablo State Park, and was designed to fit in with its rustic surroundings. The view out of the window affords a glorious picture of the California scene.

## *The Expanding Outlook*

OUR FIRST ATTEMPT at maintaining microwave apparatus was early in 1947 on the then experimental New York-Boston radio relay route. Here we were taught some basic principles. As our experience with radio relay lengthens, and new circuit designs and newly designed tubes are introduced, we become acquainted with

*Up hill in a "sno-shu." Getting off an unmarked road and onto a drift with a treacherous "overhang," like those shown behind the vehicle, is a winter hazard*

their behavior and the precise methods required to keep the network operating effectively.

As each new leg and routing has been established on the expanding Bell System radio relay network, maintenance problems and methods are reviewed on the basis of this increasing experience, and plans are made for handling the still larger network of the future.

Whether the Bell System radio relay equipment is on a mountain top, in the hot southland, or half way up a steel tower—a "cabin in the sky"—on the Midwest plains, the maintenance forces are geared to do their jobs quickly and precisely. Not all such work is done in picturesque spots, for more often than not the stations are ordinary places where there is just a room full of radio equipment at the end of a dusty road. Yet here, as in the most exciting location, a well-planned maintenance job keeps the service going strong.

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No group has been more unwisely and unfairly treated than the service industries. Yet the railroads, the power and light, the gas industries, and those furnishing communications employ millions of workers, dependent for livelihood on the success of these industries, which are vital to all other industry and to the general consuming public.

The way the government has been regulating these service industries reminds me of a gentleman who owned a farm up in my part of the country some years ago.

He had a manager who ran the farm and gave him regular reports on the operation. Now this owner figured that the way to make money on a milk farm was to watch expenses like a hawk. This he did, and complained regularly about expenses and particularly about the feed bill, the largest single item.

He finally learned—the hard way—that you don't make milk by stinting on the feed, and the same is true in regulation. If we want service from a service industry, a full diet—in terms of income—is clearly to be desired. And the people, if they understand, would want it this way. They don't go around with the balance sheet of the motor companies, the electric companies, the chain stores, etc., so as to be sure to buy the products of the companies that make the least money.

Nor do you, when motoring through the country, stop at the most run-down-looking roadside stand on the assumption that the worst looking farm sells the best produce at the lowest price. That philosophy is about on a par with the manufacturer who refuses to buy better machinery in order to reduce costs, but figures he can do it by cutting wages and lengthening hours.

Both are running against the well-established tide of American progress.

In regulating utilities and in managing other things, it is cheaper for the public in the long run to have those that serve it well-fed and strong, rather than half-starved and weak. There are ways of getting good service out of the strong. No one can get it out of the weak.

—*From an address by Sinclair Weeks, Secretary of Commerce, before American Iron & Steel Institute on May 28, 1953*

*The Methods of Employee Protection Adopted by the Bell System Companies in 1913 Have Demonstrated Their Worth To Workers, Company, and the Public Service*

# Benefits and Pensions Have Proved Value for 40 Years

## I. An Effective Adjunct to An Essential Public Service

*Eugene J. McNeely*

IT WAS 40 years ago last January 1 that the Associated Companies of the Bell System put into effect arrangements to furnish their employees certain benefits at times of illness, accident, and death, and to provide pensions for those meeting the eligibility requirements.

This was a broad and far-reaching undertaking. The men who had been given the responsibility of investigating and preparing for it realized, moreover, that they were providing plans for a complex business which was engaged in rendering an essential service to the public. The telephone business must, by its very nature, be a continuing enterprise, and its successful operation calls for a fine organization with sustained vitality.

In order to promote such an organization, these men recognized, it was advisable to make reasonable provision for those hazards of life which may interrupt earning capacity and place unexpected and sometimes heavy financial burdens upon individual employees.

They also felt it advisable to assist in solving the problem of aging personnel through an appropriate retirement plan. This, they believed, would

eliminate the expense of superannuated employees, guard against deterioration of the service, and promote the vitality of the organizations.

The farsighted vision which was woven into the Bell System companies' Plans is apparent when one considers that these steps were taken many years before such practices became general and, of course, long before the recent trends in social security now provided through legislation.

The principles involved here are especially pertinent to the telephone service, which includes a large human element. To obtain satisfactory results from such organizations, it is important that employees know their jobs and also that their morale be high. These conditions lead to efficiency and good service. The Plans have aided materially in attaining this end by providing a sense of security on the part of the employees to offset to a reasonable extent the uncertainty and fear regarding financial need which are ordinarily associated with physical impairment, old age, and death.

The results obtained from having had these Plans in effect over a period of forty years clearly demonstrate their value to the employees and to the companies.

# II. The Protection of Employees Against Certain Hazards

## *Charles J. Schaefer, Jr.*

THE BENEFIT AND PENSION PLANS adopted by the Bell System Companies in 1913 were among the finest as well as among the earliest in industry. Today, 40 years later, they are still among the leaders.

When all the features of the sickness disability benefits, the accident disability benefits, the death benefits, the disability pensions, and the service pensions are taken into consideration, they add up to Plans which rank among the best.*

A few figures will reveal some significant facts. So let's take a look at the matter of growth in numbers. In

* This general discussion cannot be complete nor definitive. A comprehensive and exact statement of the terms and provisions of the Plans is given in the pamphlet "Plan for Employees' Pensions, Disability Benefits and Death Benefits," as published by each of the Bell System companies.

1913 there were about 177,000 employees in the Bell System companies. In 1952 there were about 692,500 employees, an increase of 515,500 or almost 300 per cent, in these companies. At the end of 1913 there were about 120 pensioners, while at the end of 1952 there were about 34,000 service and disability pensioners. To set up and maintain pension plans to meet such a rapid increase in the forces introduced many problems.

Some idea of the cost of operating the Plans is obtained by a comparison between the first year's cost (1913) and the cost for the year ending December 31, 1952. During the first year, the Bell System companies, including the Western Electric Company, paid out $1,153,128 for all the purposes covered by the Plans. In the year 1952, the amount was $213,825,349. This latter sum is made up of the following items:

| | |
|---|---|
| Sickness disability benefits | $ 32,856,327 |
| Accident disability benefits | 1,915,884 |
| Death benefits | 6,905,397 |
| Disability pensions | 3,001,809 |
| Payments to Pension Trust Funds | 169,145,932 |
| Total | $213,825,349 |

In addition to the above, the Companies paid out during 1952 $28,646,173 from operating expenses for the first seven days' sickness absences † and other miscellaneous items; and $33,533,186 in Social Security old-age insurance benefit taxes. This makes a grand total of $276,004,708.

† Any payments for illnesses of less than eight days are not charged to the Benefit Plan accounts.

## *Before 1913*

THE BELL SYSTEM COMPANIES' benefit and pension plans went into effect on January 1, 1913; but they did not spring into existence over night. A great deal of research, of planning, of plain hard work preceded their adoption.

At the time when the plans became effective there were, in addition to certain governmental plans, some pension plans in older industries—more particularly the railroads. But by and large, these covered only a small portion of the employees in industry. For others, any forms of protection, if provided at all, were entirely discretionary, and there was little assurance of security or uniformity of

treatment. With increasing industrial expansion, however, the need for such protective measures for employees was becoming more fully recognized.

Before 1913, a number of the Bell System companies had informal practices which provided financial assistance in connection with disability and death and which assisted in varying degree those long-service employees who, because of age or other infirmities, were unable to continue on active duty. In other instances, some protection was provided by mutual-benefit associations or through similar employee activities—with or without company participation. A few of the older companies had somewhat uniform practices in effect which made some provision for retirement, and one company had adopted a formal retirement plan as early as 1906.

The Plans adopted in 1913 by the Bell System companies provided uniformly substantial benefit and pension protection; and, through interchange agreements, they enabled employees to move from one company to another in the System and continue to enjoy the advantages of the Plans. This was and has continued to be distinctly advantageous to both the employees and the companies.

In the past 40 years, the Bell System Benefit and Pension Plans have been amended on a number of occasions to meet changing conditions, and these amendments have meant a broadening of the provisions of the Plans, to the advantage of employees.

The effect of the Benefit and Pension Plans upon employees is to cushion the blows of illness, accident, old age, disability, and death. Their economic and administrative justification lies, however, in their ability to maintain, within an essential public service, organizations of sustained spirit and vitality. Contributing substantially to these attributes are the features of the Plans which provide an orderly program of retirement for older employees. Since the inception of the Plans, 49,425 employees have been retired on pensions.

The principles underlying the Plans are that they be designed to meet effectively, for the future as well as the present, the needs of the business; that they be financially secure; and that they balance fairly the particular interests of telephone workers, telephone users, and telephone share owners. The interests of these three groups are interdependent.

The benefit and pension provisions of each of the companies' Plans are important in achieving these purposes.

The sickness, accident, and death benefits—which, like pensions, are provided at company expense—bear a fairly constant relationship to wage and salary payments, and so they are paid out of current expenses as required.

## *The Pension Plans of the Bell System Companies*

THESE PLANS are generally accepted by pension authorities who are familiar with their provisions as exceptionally good and, indeed, outstanding industrial plans. They are financially sound, and their eligibility provisions treat all employees alike on the basis of their wages or salaries and the length of their service in Bell System companies. They are "trusteed" Plans, for which funds are provided on a sound actuarial basis so that pensions will be available for employees when they retire.

It is essential to the best interests of every employee that the terms and conditions of the Plans be maintained in accordance with sound pension practices. A pension plan is not something which can be changed from year to year; pension planning is by its very nature a long-term proposition, and must be so recognized if it is to be more than a temporary gesture.

Pension plans cost a lot of money. In order to provide essential security for the future, there must be reasonable assurance of meeting the bills in the years ahead—in good years and bad years. Without such security, pension plans are unreliable promises.

Good pension plans must be thoughtfully conceived, carefully designed, fairly administered, and soundly financed for the long pull.

## *Special Features of the Plans*

IN THIS COUNTRY TODAY about 15,000 pension plans of various types are in effect. They are too numerous and varied to permit comparison here, but some of the features which distinguish the pension plans of the Bell System companies from others may be pointed out.

These Plans of the Bell System companies are non-contributory, and their payments are provided without any direct or indirect cost to employees. So, in making comparisons with plans to which employees contribute, it must be kept in mind that a part of the pension under such plans is purchased by the employees' own contributions. The pensions compare most favorably with the part provided solely at company expense in these other plans.

Another point to take into account is that while every Bell employee begins, on the day he or she enters the business, to acquire credited service for eligibility to the Pension Plans, many other plans limit employee participation in terms of age, of earnings, of length of service, or in other ways.

A number of plans require, for instance, that employees be 25, 30 or even 40 years old before they can receive pension credits or participate in the pension plans. The most common age requirement is 30 years, and if this were used in computing Bell System pensions, it would reduce most of them by very substantial amounts.

Another requirement of some pension plans is a certain period of service—usually from one to five years—before an employee may participate in the pension plan. This practice, too, if applied to Bell System pensions, would reduce them substantially. If, for example, five years of service were required before an employee began to receive pension credits, the amount of the service pension would be reduced, on the average, by about 15 per cent.

Another common practice in pension plans is to "discount" pensions granted ahead of the normal retirement age. In these plans, the normal retirement age is usually 65, and the pension as computed by the regular formula is discounted for each year of retirement before 65. On the average, Bell System men retire at age 63 years and women at 58. If the discount feature common to most plans were applied to our pensions, men's pensions in the average case would be reduced by about 15 per cent and women's pensions by almost 40 per cent.

Some pension plans compute pensions differently for employees in different wage or salary groups. In the Bell System, all pensions above the minimum are figured on exactly the same basis for everybody.

## *The Pension Plans and Social Security*

ALTHOUGH it is customary in the great majority of industrial plans to make adjustments in pensions, directly or indirectly, because of Social Security benefits, this common practice has been the subject of considerable misunderstanding. It may be useful, therefore, to review briefly the underlying principles regarding the practice as it applies to the Bell System companies' Plans.

Looking ahead 40 years ago, the men who worked out the various conditions of the Plans could see even then the future possibility of laws requiring all industries to pay for pensions to their retired employees. But since those men were then establishing a pension system paid for wholly by the companies that was fair and liberal, they included the proviso that any pension set up the government should become part of the retirement income the companies provide for their employees.

In other words, the pension plans have included for 40 years the sensible provision that the companies shan't be put to the expense of duplicating their benefit or pension payments.

More than 20 years went by before that particular proviso had much application—other than avoiding the duplication of accident disability benefits provided by the plans and workman's compensation payments required by law. Then, in 1935, Social Security became law. The law requires that Bell System companies, along with all others, make payments into a national pool or fund from which benefits will be paid, under certain conditions, to qualified persons at age 65.

So there were the Bell System companies, paying into two pension funds: their own long-established funds, and the government's new fund. That was the situation which had been anticipated.

There is one aspect of it which had not been foreseen, however. This is

that by law both company and employee pay—and pay equal amounts —into the Social Security fund.

So, instead of considering *all* of the amount of the Social Security pension in the retirement income the company provides for its employees at age 65, the company includes only half of it. This is because the company and the employee pay equally into the Social Security pool, and it seems fairer to count only the half of the Social Security pension which the company paid for in figuring the total retirement income which the company provides for its employees when they reach 65.

Social Security payments do not begin until age 65. So a company employee who retires before that receives his or her pension from only one source: the company's pension trust fund. Beginning at 65, the employee receives his or her pension from two sources: Pension Plan trust fund of the company, and Social Security fund; and the total then equals the full amount of the retirement income provided at company expense *plus* the half of the Social Security pension resulting from employees' tax contributions to the government through payroll deductions.

Social Security old-age benefits represent a form of group insurance, as contrasted with benefits provided on the basis of individual contributions. As is true of any insurance system, the Social Security Act gives the assurance of protection to all who become eligible for payments, at the general expense of all who contribute in the form of taxes to the fund from which the payments are made. For this reason, the total amount of Social Security benefits which any individual may receive cannot be related to the total of the taxes which have been contributed either by him or by his company in his behalf.

As under all insurance systems, some people stand to get more than others; some will receive more and others less than the total amount of

taxes which they and their employers have contributed. This "averaging" is the fundamental principle on which all forms of insurance are based. Just as it is inconsistent with the basic theory of the Social Security Act to relate the Social Security benefits received by an employee to the taxes he has paid, it is also inconsistent to relate the adjustment of his company pension to the taxes paid by the company in his individual case.

So long as industries are expected to provide one-half the funds from which Social Security benefits are paid, it follows that they must, over the long pull, coördinate the pensions provided under their private plans with Social Security payments. Money paid to the Government by the Bell companies to provide pensions for the employees who work for them must be considered along with money paid out to meet the expenses of their private pension plans. Both of these items represent real costs to the companies; in the long run their Pension Plans, to avoid duplication of pensions at company expense and to be of a sound and continuing character, must give full weight to the fact that half the Social Security payments are financed by the companies. The Plans are similar in that respect to most other industrial pension plans.

## *Security of the Pension Plans of the Bell System Companies*

TOO MUCH emphasis cannot be placed on the prime essential of any really good pension plan: *security*.

Unless there is security, employees have no assurance of receiving the

pensions to which they have become eligible upon retirement. When insecure pension plans fail, they work grave hardships on employees at a time when their earning powers have decreased or ceased entirely and when they will probably have little chance to get going again to provide for their later years. This has been the unfortunate experience in a number of other pension plans over the years, especially during depression periods.

The Plans are outstanding in respect to their security. The pension funds trusteed under the terms of the Plans must be used *solely and entirely* for service pension purposes. Amounts accrued on an actuarial basis are paid into the funds currently, to provide for payment in full of the pensions as they become due and for the continuation of such payments during the remaining lifetime of the retired employee. The amounts thus provided over the years are sufficient to meet, by a substantial margin, all matured pension liability: i.e., the amount required to pay in full the pensions of those already retired and those entitled to retire at their own request. The balance in the funds, with current accruals and interest earnings, will provide for future pensions as employees become eligible to them.

WITH such essential security, with due recognition of important pension principles, and with the application of good judgment, the Benefit and Pension Plans of the Bell System companies will continue in the years ahead to fulfill their important functions, to the mutual advantage of employees, share owners, and the public.

*Prolonged Disruption of a City's Electric Power Plant Put Telephone People, Equipment, and Emergency Plans To a Severe Test*

# "The Service in Toledo Did Not Break Down"

*John H. Page*

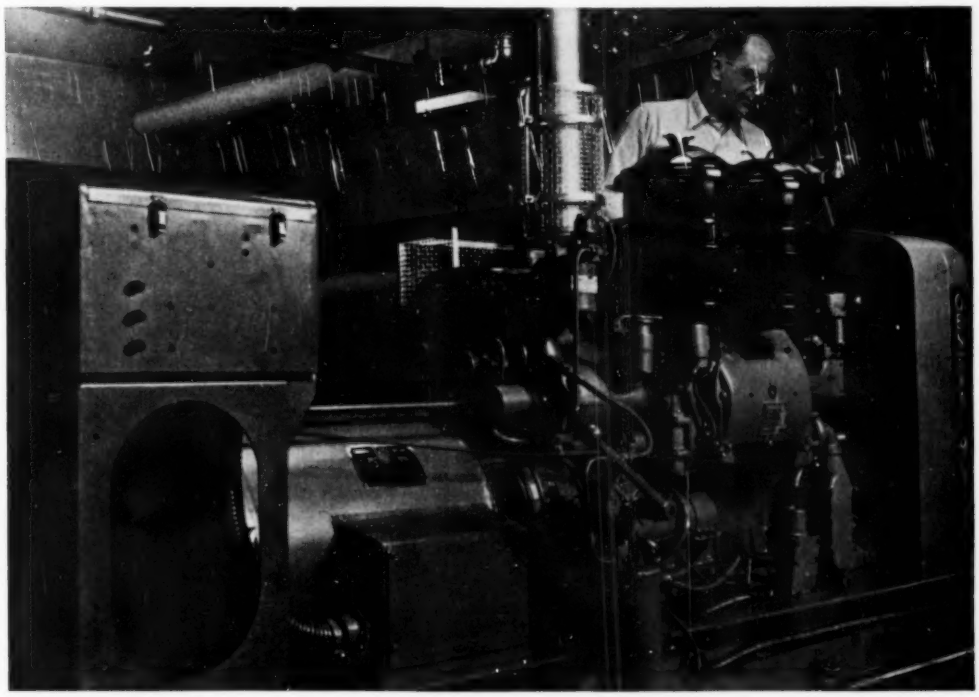
*That telephone service in Toledo did not fail is not surprising: it is failure which would have been surprising. For throughout the Bell System, plans have been made and equipment has been installed to safeguard the pathways of communication against hazards far greater than those encountered in the Ohio city last April. The incident is recounted here, therefore, simply as indicative in some measure of the readiness of the System—its people and its plant—to meet and handle whatever kind of emergency, from whatever source and wherever encountered, these troublous times might bring.* EDITOR

RESIDENTS of Toledo, Ohio, woke up to quite a shock on last April 6th.

In the first place, some of them were a little chilly, for their electric blankets had gone off at 6:05 a.m. Then electric razors wouldn't work, toasters wouldn't work, electric stoves wouldn't work, the lights in the closets wouldn't work—but this was minor. After all, the electricity had failed before for short periods, so the man of the house dug out his safety razor and resigned himself to an old-fashioned shave. Then he turned on the water tap—and no water flowed. "This *is* unusual," he thought. "I'll try the radio to see what's happened"—and it didn't work.

"How about the telephone?" He tried it—it *did* work. In fact, it worked overtime. It handled nearly three times as many calls in Toledo on April 6 as on a normal day.

Of course, for the telephone to work during a minor power failure is hardly news, but the April 6 power failure in Toledo was unusual. It



*A modern generating unit, with completely self-contained cooling system. It is capable of supplying all power requirements of a central office, including normal lighting—and did so at the Walbridge office during the Toledo power failure*

was complete and prolonged. All parts of greater Toledo were without electric light and power for nearly two hours, and it was nearly five hours before electricity once more surged through all the power lines. This meant hospitals, fire departments, business buildings, factories, radio stations, homes—all segments of the community—were at a standstill. Moreover, since the pressure for Toledo's water system is provided by electricity, it too came to a dead stop.

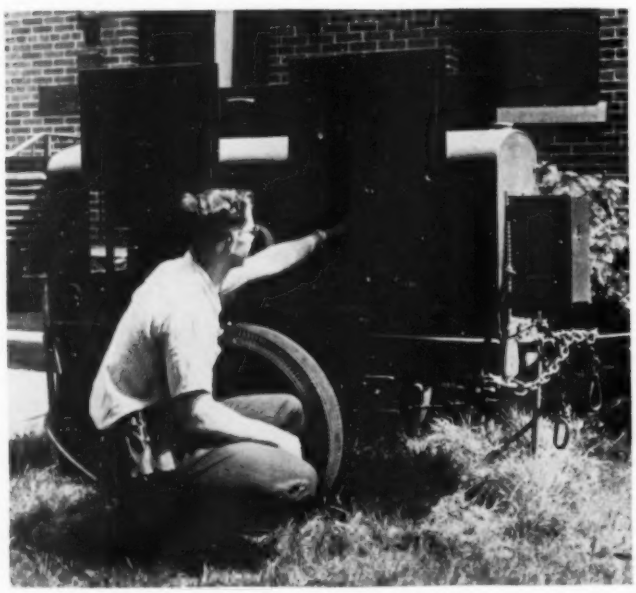
While this Toledo "disaster" was not in any way comparable to a major catastrophe, or what would occur in the case of a bombing attack, it did provide an opportunity to see how telephone procedures, equipment, and personnel functioned in an actual case. As one plant man put it, "We learned more in those five hours than we ever did in our many 'paper' disasters."

## *Emergency Equipment on Hand*

GREATER TOLEDO is served by step-by-step dial equipment in six main central offices and four community dial offices. Here is a quick look at how each of these operating units worked without the electricity normally supplied by the Toledo Edison Company.

At 6:05, when the power failed, all battery charging equipment stopped. Telephone service did not. Batteries took over the job of supplying

needed power. In the six city central offices, auxiliary gasoline or diesel engines driving generators were soon started, to keep a steady surge of electricity flowing into the batteries.



*A typical gasoline-driven portable generating unit outside the Perrysburg community dial office. The upper picture shows how its conductors are plugged into the terminal outside the building*

In the four community dial offices, there are no auxiliary engines for running generators. Ordinarily, the batteries will carry these offices for a good many hours, but central-office foreman Walter Hettle was taking no chances and, within an hour, had portable generators beside three of these offices. The fourth office was unaffected, being outside the power failure area. The generator at one community dial office was used for about an hour before the power was restored. At the other two C.D.O. offices, the generators were not used, as the power came back on before they were needed.

In town, in the main central offices, other problems were confronting telephone people. At the Pontiac, Lawndale, and Jordan exchanges, the lack of water was causing trouble. At Pontiac and Jordan, this problem quickly solved itself when the water pressure was restored about 7 o'clock. At Lawndale, however, central-office foreman Frank Randall found this didn't solve his problem. When the water came back, he again started up his auxiliary generator; but the sump pumps, for removing the cooling water from the basement, were dependent on commercial power, and didn't work. But Frank Randall was equal to the occasion: he called on the Construction Department to bring over an auxiliary pumping unit to

empty the basement of the cooling water. And, just as double protection, he procured a portable generator, which he kept standing by.

What must have made Frank Randall's job the more frustrating was that sitting in the basement, all ready to go except for the wiring of the control panel, was a new diesel generator with a self-contained cooling system. Similar auxiliary generators with their own cooling systems had already been ordered for the other offices, even before this emergency emphasized the need for such equipment. Had the water failure persisted, still other—if more complex—methods were available to get the generators going in time.

*Much work and planning has been undertaken to make the telephone system capable of withstanding unusual conditions. It is not the purpose of this article to evaluate the strength or weakness of our disaster planning and procedures; but, in gathering the material for this story, one cannot help but be impressed by the effectiveness of what has been done for just such an occasion. Likewise, one cannot help but be impressed by the performance of telephone people during this power failure.*

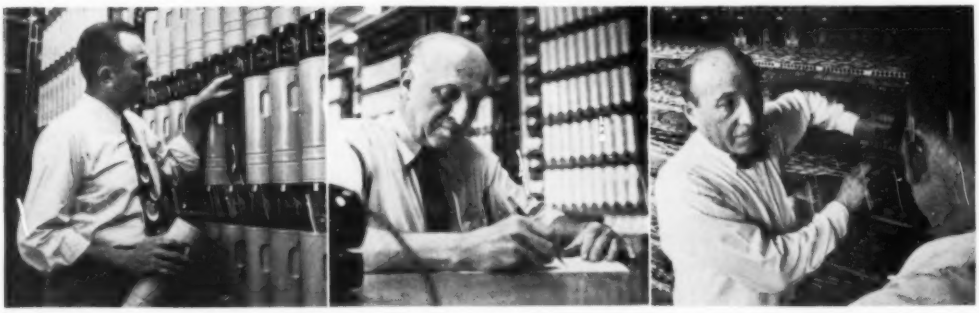
## *The Message Went Through*

IN THE MAIN BUILDING, where the Main–Adams central office is located, and at the Walbridge central office, things were running more smoothly. At both of these locations, diesel generators with self-contained cooling systems were steadily pushing the needed electricity into the telephone system. In fact, in the Main building, all lights were working and one elevator was delivering passengers in normal fashion.

Some of these passengers were extra operators for the D.S.A. switchboard, for this board was very busy. Chief Operator June Mangold was home in bed at 6:05 when the night chief operator called her. By 6:30 she was in the office. She held night operators over, and quickly filled all her positions by calling in extra operators and borrowing girls from the toll office.

Apparently a great many people rely on electric clocks to govern their day-to-day operations, for the TIME OF DAY service was extremely busy. So was the Toledo Edison number—with nearly every Toledoan trying to get his personal complaint to the beleaguered utility. Many of these calls ended up at the D.S.A. board, and here the operators did yeoman service explaining the power failure and re-orienting many a time-conscious American. Some probably missed their regular bus despite the girls' help—but this wasn't a normal day in Toledo.

Of course many a call was made next door, to families, and to friends, to see how they had cooked breakfast or heated the baby's bottle, but emergency calls also helped build up the load far beyond normal. Interestingly, some of the emergency calls were made by the Toledo Edison Company in procuring reserve power from the Midwest power pool.



*They knew what to do and how to do it, and knew they had the authority to do it: Central Office Foremen Frank Randall, Otho Banning, and Edward Lasko*

Actually, the power failure was the result of trouble in a circuit breaker at Toledo Edison's main generating plant. This caused a 69,000-volt arc to flash into the bus structure, through which all electricity is distributed to the various power lines. It was because this key distribution point suffered damage that Toledo Edison took longer than usual to switch in reserve power from other sources in the Midwest area.

## *The Plans Are Made*

TO MANY CUSTOMERS, one of the qualities that makes a telephone invaluable is its reliability. To the customer, this means constant convenience and, in times of emergency, protection for his home and family. The Bell System has always recognized the importance of providing reliable service. The concept of preventive maintenance, high standards of equipment, and many practices and policies are a direct effort toward this. Today, the importance of reliable service has even greater significance because of the possibility of hostile attack and the resultant importance of dependable communications.

In Toledo, emergency procedures had been worked out during regular monthly meetings of the Disaster Committee. Auxiliary generating units existed in all main exchanges, and nine portable generators of various capacities were on hand in dispersed locations. All units were tested and run weekly, and people were trained in their use. These and many other actions made our plant capable of continuing to give service during the power failure.

But, when all is said and done, these preparations alone would not have kept the service functioning. People were needed to direct and use this equipment.

In the Toledo case, five central office foremen and a chief operator, representing 192 years of telephone knowledge and experience, were the key people. They knew what to do, they knew how to do it, and knew they had the authority to do it. True, hours and hours of laborious planning and effort to provide them with needed equipment stood behind

*These six supervisory people have a total telephone experience of 192 years: Central Office Foremen Walter Hettle and Charles Ragen and Chief Operator June Mangold*

them, but in the emergency they acted—they used the equipment on hand to see to it that the telephone *did* work. Their experience and capacities, like their colleagues' all over the Bell System, are an unvaluable asset available in any emergency.

As one plant man put it, "Everything didn't work perfectly, we hadn't foreseen all the situations, but it certainly shows we are on the right track; and, what is important, the service in Toledo did not break down."

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# The Spice of Life

(From the London *Times*)

The telephone directory is generally considered to be a pretty unexciting publication. It is true that its growing bulk reminds the possessor of a telephone of the startling fact that he can be rung up by more than five and a half million other subscribers in this country alone. Yet, on the whole, the neatly printed columns, the serried ranks of Browns and Smiths contain little to fire the imagination.

The classified directory is another matter. At first sight this appears to be a mere rearrangement of the same names under convenient headings, a splitting up of the Browns and Smiths according to their occupation as solicitors or ladies' hairdressers, building contractors or doctors.

The telephone subscriber in the London area who idly turns the pages of this formidable volume finds, all the same, quite a few surprises. There are, for example, the farmers—820 of them—to show that within its wider confines the capital is not all rooftops. . . .

Makers of air-tight chests and bowling greens, of crimped paper cups and collapsible gates, of bandsaws and bung tins are listed for him in the book. Telephone cleansers and tripe dressers, turtle merchants and caviare importers await his order.

To arouse his curiosity there are manufacturers of kieselguhr and Tripoli powder, cullet merchants and pirn makers. If these do not satisfy his wants there are stabilizing food agents, glass benders, oily water separators, and a solitary flong merchant.

"When a man is tired of London," remarked Samuel Johnson, "he is tired of life; for there is in London all that life can afford." The aphorism seems to be as true today as ever it was.

*Three Decades of Organized Campus Recruiting of Qualified Seniors Supplements Leadership Potentialities of Able Men And Women Already in the Organization*

# Bell System Employment for College Graduates

*Donald S. Bridgman*

THE BELL SYSTEM'S 1953 college recruiting efforts are now about over. Recent graduates of two or three hundred American colleges and universities have elected to join one or another of the System's score of organizations. By now they either are getting used to their new jobs in the telephone business or are about to report for their first assignments.

Graduation put an end to active recruiting efforts for 1953, it is true—but not to the recruiting program. That is a continuing activity, which has been going on for many years. As long ago as the beginning of the present century, individual executives of some Bell System companies had been going to certain colleges in an effort to interest able seniors—mostly engineering students—in entering their companies after graduation. By the onset of World War I, this activity had expanded into some organized interviewing on college campuses by a few System companies.

With the expansion of the telephone business in the 'twenties, there was an increased need for college graduates, and most of the System companies began to visit college campuses regularly in search of first-rate men—still largely graduates in engineering and physical science. In 1922 a coördinated plan for college recruiting in the Bell System was established. This plan, which has been developed and improved over three decades, is in effect today.

## *Purpose of the Program*

THE BELL SYSTEM'S college employment program exists for the purpose of securing from the country's colleges and universities the services of young men and women who can provide specialized knowledge and skills and, in addition, a leadership potential to supplement that of outstanding employees who are coming up through the ranks.

*Part of the Murray Hill, N. J., installation of the Bell Telephone Laboratories*

The program is a natural outgrowth of the increasing number of young people who take advantage of the many opportunities in this country to obtain college educations. In 1900, only one young person in 60 graduated from college; today about one in eight does so.* For men, the present ratio would be about one in seven; * for women, one in eleven, since men receive more than sixty per cent of today's bachelor's degrees.

No longer do the colleges attract only those students who come from well-to-do families, as was largely the case fifty years ago. Regardless of their parents' circumstances, many young people of ability and determination now find reasonable ways to secure college training, and enter their life work only after completing it.

The native ability of most graduates, moreover, has been further developed by intellectual discipline and contact with many different fields of learning through their college years. Knowledge and skill in some of these fields, such as engineering and physical science, economics and other social science, and accounting, statistics and other aspects of business administration have become increasingly important for business organizations and are acquired through extensive college training. Here again, there has been a great change since early in the century, when nearly half of all college graduates were preparing for the professions of law, medicine, dentistry, and the ministry. Today only seven or eight per cent are doing so, and the majority look forward to business careers.

Both such developments in college education and the increased complexity of business led the Bell System companies, as well as many other organizations, to seek college graduates for technical and other phases of their work and to provide a reasonable proportion of their future leadership.

* Ratios do not include veterans whose graduations have been delayed.

### *Limited Numbers to Be Employed*

IN DETERMINING the number of college graduates to be employed over a period of years, the Bell System companies are governed by three principal criteria:

(1) How many graduates will be needed to fill positions requiring technical or other specialized college training?

(2) How many with such training or more general college training will be needed to fill future management positions without blocking opportunities for the advancement of equally able non-college employees in the ranks of the business?

(3) How many graduates can progress in the business in line with the investment of time and money in their education, their reasonable expectations, and their opportunities in other fields?

The Bell System companies also recognize fully that they have in their ranks large numbers of able employees without college training or, in some cases, uncompleted college training, who are highly qualified candidates for supervisory, staff, and executive positions. The appeal of telephone work generally and the careful selection of all System employees make it inevitable that among the men and women in these companies there will be many who have the outstanding character, personal qualities, and intellectual ability which, added to the knowledge gained from experience, result in fine leadership potentiality. Management gladly accepts its responsibility to develop fully and advance such employees.

Certain characteristics of this business, however, make it particularly important that the Bell System obtain a substantial number of the country's new graduates of outstanding ability and finest training. These include the System's constant search for improvements and economies in its services, the complexity and highly technical character of telephone equipment, the need to exercise good judgment in making large expenditures, and the variety of its operations.

Fortunately, the telephone business offers an unequalled opportunity to those graduates who demonstrate outstanding ability and future potentialities to utilize their special training and to fulfill their purpose in securing it. Such an opportunity grows out of the interesting and varied work to be done, the rapid growth of the business and the chance for advancement that accompanies such growth, and the satisfaction that comes from participation in an essential, forward-looking service industry.

### *Thirty Years of Activity*

WHAT HAVE BEEN the effects of this program over the past thirty years on the balance today of college graduates and other employees in the supervisory, staff, and technical positions of the System Companies? As might be anticipated, the proportion of graduates in such positions is highest in Bell Telephone Laboratories, where thor-

ough training in engineering or physical science, either in college or by intensive self-study, generally is indispensable. Of the Laboratories' technical and other staff positions, five-sixths are filled by college graduates, of whom almost one-third have masters' or doctors' degrees. About one-eighth of these graduates, recognizing the importance of technical training for the Laboratories' work, have obtained their degrees through evening courses.

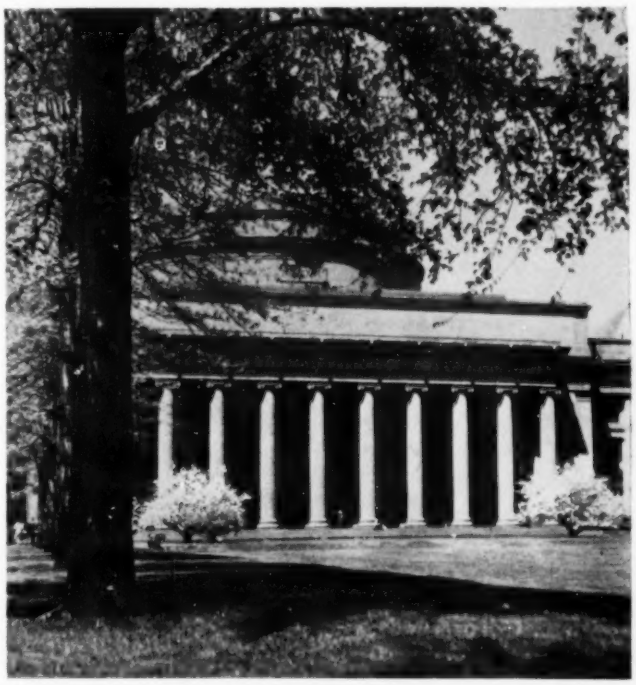
In the Operating Telephone Companies, college graduates fill approximately half of all positions at and above the district level or its equivalent. Naturally, this ratio varies between companies and, within the companies, between departments. It tends to be highest in the Engineering Departments because of their special technical requirements and lowest in the Plant Departments, with their large reservoirs of able non-college men.

In the Western Electric Company, the situation is similar, with about half of the positions at the level of assistant superintendent or above filled by college graduates.

For individual promotion, of course, the selection is based on established merit of the candidates, regardless of educational background except as requirements of the position make them important.

### *Organization of Recruiting Work*

As THE IMPORTANCE of college graduates to the business increased with their rising numbers, organized efforts have developed to secure those graduates best fitted for the System's work, and for some years college recruiting has been on a systematic basis. Today, under this plan, each Operating Telephone Company is primarily responsible for maintaining relations with the institutions in its territory and for making arrangements for visits of representatives of any Companies interested, to interview candidates for employment. At each institution from which more than one System unit wishes to secure men, these representatives visit the campus as a team, and each candidate is enabled

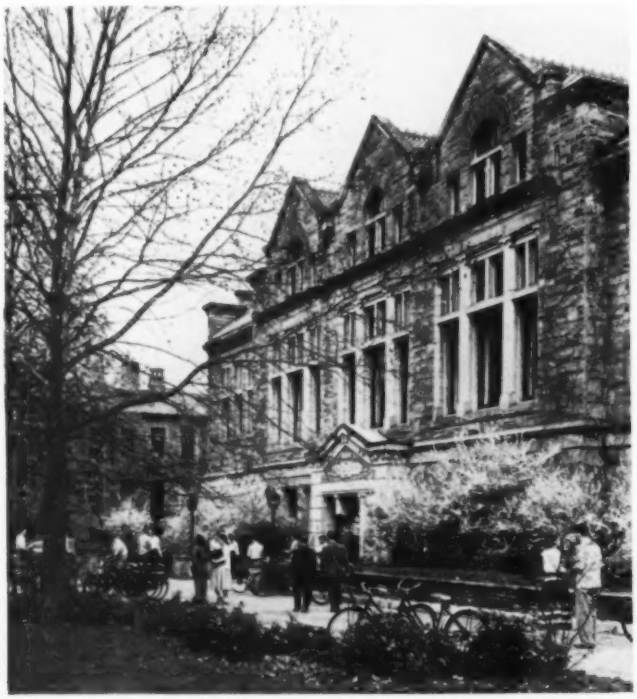


*Massachusetts Institute of Technology, one of the many engineering schools whence recent graduates enter the Bell System*

to interview the representative of any Company in the work of which he has a special interest. At the larger technical institutions, such a team is generally made up of representatives of the Associated Company in that territory, the Western Electric Company, Bell Telephone Laboratories, frequently of the Long Lines, and in recent years the Sandia Corporation—which is operated under contract with the Atomic Energy Commission by the Western Electric Company.

Students who are interested in Companies which are not represented on the campus, particularly Associated Companies at a distance, are interviewed and their records are referred to those companies for consideration. Through these arrangements, the whole range of System opportunities in all parts of the country, including operation, manufacturing, and development and research, can be presented to students of varying interests, and those who appear to be well fitted for Bell System work may receive offers of employment, or assistance in arranging subsequent interviews, with the System company for which they have the greatest interest and aptitude.

This type of recruiting activity on college campuses has become more and more essential because of similar efforts carried on by an increasing number of other businesses. As a result, a high proportion of the outstanding men in each senior class are likely to have accepted employment some time before graduation. Recruiting activity on the college campuses, however, in addition to providing direct access to outstanding men there, tends to stimulate interest in the Bell System's work on the part of other students who may delay selection of their first job or who may find it necessary to change employment some time after graduation. For this and other reasons, a substantial number of well-qualified college graduates are employed as the result of direct application at Bell System offices.



*Oberlin College, one of the smaller Arts institutions contributing their share of graduates to Bell System enrollment*

Since the start of the Korean war, the large

requirements of the Western Electric Company and Bell Telephone Laboratories in connection with their contributions to the defense effort, in addition to their work for the Bell System, have substantially increased the needs of those companies for engineering graduates. Similar needs have developed in outside industries and, as a result, the demand for new graduates in engineering in recent years has been greater than the number of men receiving degrees.

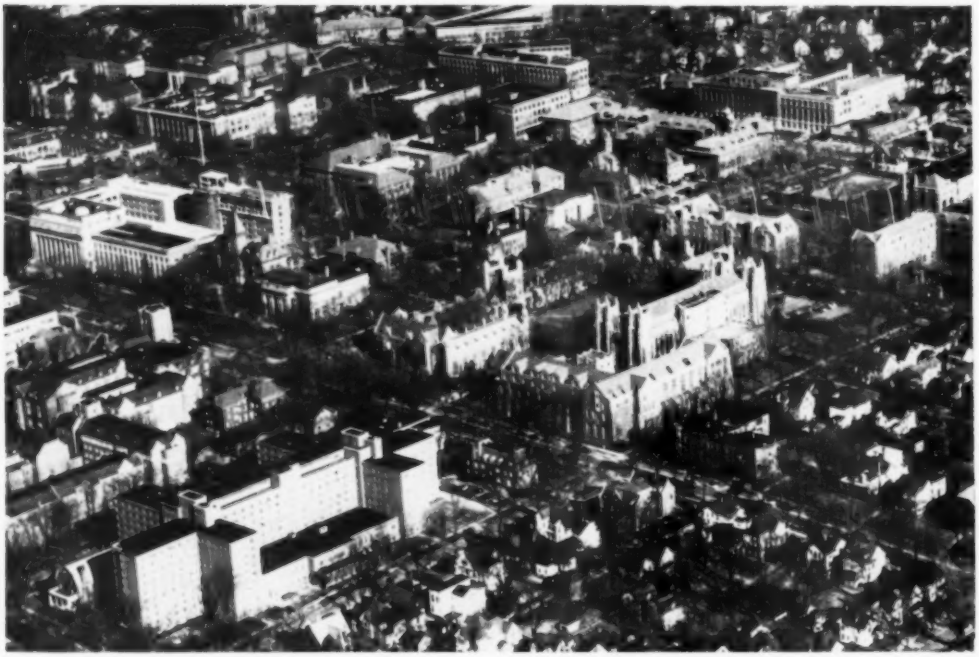
*Bell System buildings—such as this of the Ohio Bell Telephone Company in Dayton—are architecturally appropriate to their surroundings, and in their substantial character and careful planning reflect the stability of the business and its regard for customers and employees*

### *The Bell System and the Colleges*

THE SUCCESS of the Bell System's college employment program will depend in the long run upon cordial and mutually constructive relations with the colleges and universities and their faculty members. Since the establishment of coördinated college recruiting, early in the 1920's, a number of activities have been undertaken to promote such a relationship.

In order to assist the larger engineering schools in their teaching of problems most usually encountered in communications, a substantial amount of communications laboratory equipment has been made available to a number of such schools. During the 1920's, the Bell System companies held three conferences with faculty members in the fields of electrical engineering, mechanical engineering, and business administration and economics, to acquaint them with problems encountered in the telephone business, and the types of opportunities it offered to their graduates.

During more recent years, one Bell System company has held similar conferences with college faculty representatives, primarily to give them a better understanding of the telephone business; and other Companies are planning similar conferences. Such meetings improve college relations in general, and strengthen the opinion that the Bell System is a good place to work.



*University of Michigan is one of the large state universities whose recent graduates find employment in the telephone business*

Statistical studies of the relationship between certain factors in the college record and later progress in the System companies were undertaken more than 25 years ago, and the results of the first study of scholarship for this purpose were published by Mr. Gifford in 1928. This study brought out that, in general, the probability of above-average progress in the System's work was definitely greater for the type of men who had stood high in their college classes than it was for those whose records had been average or below. As the result of additional studies, a similar but somewhat less significant relationship was found between extracurricular achievement in college and progress in the System. More limited studies of this same kind have been conducted from time to time in the intervening years and in general have confirmed the results first obtained. Similar analyses are being continued. The general conclusion to be drawn from this work is that although for large groups of graduates better than average achievement in college is likely to be followed by similar progress in business, there are many individual exceptions. Certainly, there is no single objective factor, such as college scholarship, or any combination of similar factors, which will predict success in the Bell System's work with any degree of accuracy. Sound judgment, based on experience and taking into account factors of this kind, appears to be the most satisfactory method. This whole area, however, is one which requires constant study in order to make certain that the best qualified men are being selected.

### *Selection and Initial Training of Graduates*

FINAL SELECTION of college graduate candidates is based on careful interpretation of all the evidence which can be secured concerning each individual's character, abilities, and interests, in relation to the work for which he seems best fitted. Decisions are reached on the basis of personal interviews, faculty opinion, and appraisals of past performance in college, previous employment, and, where applicable, military service.

Each of the Bell companies conducts an initial training program for recent college graduates. These consist primarily of a series of rotated work assignments rather than of observation and classroom study—although those methods are used to some extent as seems appropriate. These assignments, of course, frequently involve specific training which is given to all employees undertaking that work. In some of the Operating Companies, assignments are interdepartmental in order to provide a broad background of knowledge of the company's activities. More frequently, in the Operating Companies and in the Western Electric Company, following a brief orientation period, these assignments are within a specific department for the work of which the individual candidate seems best fitted by interest and training. With opportunity in every department, his future progress, of course, will depend on performance and merit.

In a number of the Companies, non-college employees who have shown special ability warranting consideration for promotion are included in the same initial training program.

Bell Telephone Laboratories has established a training program for its young engineers entering the development departments which provides classroom instruction of graduate level in communications technology, accompanied initially by rotated work assignments. The length and character of an engineer's participation

*Kearny Works of the Western Electric Company, manufacturing and supply organization of the Bell System*

depend on his aptitudes and interests and the current needs of the development program.

### *Employment of Women*

ALTHOUGH some of the points which have been discussed are applicable both to college men and to college women, the number of college men employed and the organized activity which has gone into their employment program have been substantially greater than in the case of the women. However, as a result of expanding opportunities in the Bell System for college women, a number of the Companies have organized campus recruiting for them in recent years. It is anticipated that there will be an increasing need for able college women in the System companies.

THE COLLEGE EMPLOYMENT PROGRAM of the Bell System companies illustrates the broad principles that all appropriate sources of personnel should be used to secure those best qualified for their widely varied activities, that those from each source should be assisted to develop to their fullest capacity, and that promotion of those from all sources should be based on performance and merit.

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## Bell Telephone People Win Safety Award for Second Successive Year

Bell Telephone men and women have won for their companies the National Safety Council's top Award of Honor for the second successive year.

The latest award, covering 1952, is based on a 50 per cent improvement in the accident frequency rate, compared with the average for Bell Companies and the communications industry during the three previous years.

F. R. Kappel, vice president, Operation and Engineering, A. T. & T., said, "Bell Telephone men and women everywhere can be deeply proud of their achievement. . . .

"They did a fine job in winning the award for 1951. They did an even better job in winning it for 1952. In fact, their 1952 safety performance was the best in the history of the Bell System. . . .

"That is a splendid performance. It reflects the combined efforts of all the men and women in every department and branch of the System.

"We are able to work five times more safely than the average industry reporting to the National Safety Council. This clearly demonstrates the practical value of programs of accident prevention. Carefully planned job operations and approved procedures are both essential and effective in getting things done safely.

"Safety is good business. It reduces waste, suffering, heartaches and financial loss. We can never have too much of it. The more we have, the better off we are.

"This award not only does great honor to the men and women who have won it; I am sure it will also help us to make even further progress in the years ahead. And we shall all gain the benefit, for every contribution we make to the cause of safety works to our own immediate and personal advantage."

*Twenty-five Years Ago in the* BELL TELEPHONE QUARTERLY:
*Volume VII Number 3, July, 1928*

# "The Honour of Kings"

## *By Frederick L. Rhodes*

*Mr. Rhodes joined the American Bell Telephone Company in Boston in 1892 as an engineer, and retired as outside plant development engineer of the American Telephone and Telegraph Company in New York in 1932. His death occurred the following year. His 40-year telephone career was devoted to the development of outside telephone plant, to which he made notable contributions. He was a studious and cultured man, and his books "The Beginnings of Telephony" and "John J. Carty—An Appreciation" are regarded as authoritative. The following statement, reprinted just 25 years after its original publication, is apt in conjunction with the article by Dr. Kelly which heads this issue.* EDITOR.

ALEXANDER GRAHAM BELL did not discover the telephone by haphazard. His invention was not an accident; it was a matter searched out. Before the first telephone was made, Professor Bell had formulated, in his mind's eye, the theory that electric currents, generated by a voice-vibrated armature in front of an electromagnet, could be made to produce electrical effects capable of transmitting speech. In the workshop of Mr. Charles Williams, Jr., 109 Court Street, Boston, on the second day of June, 1875, he confirmed his theory in the course of his classical experiments with tuned reeds, made preparatory to an experiment with multiple telegraph apparatus. When, on March 10, 1876, he said, "Mr. Watson, come here; I want you," and his words were transmitted over a short length of wire from his laboratory to his bed room, in the boarding house at No. 5 Exeter Place, in Boston, and faithfully received, a new era in communication unfolded.

Research and development, in the system which bears his name, began with Bell. There is a passage in the Book of Proverbs which seems particularly applicable: "The honour of kings is to search out a matter." That is what Bell did; it is what his successors are still doing. His name heads the unbroken dynasty of scientists and engineers whose efforts, through half a century, have nur-

tured the telephone art from its simple beginnings to the complex organism which today makes neighbors of more than a hundred millions of Americans and, spanning the Atlantic, links the peoples of two continents in the bonds of speech.

WHEN THE TELEPHONE was born, there was available for use with it none of the thousands of parts now essential to a far-flung communication system. Knowledge, of course, existed of certain properties of the metals, such as copper, iron, nickel, platinum, lead, antimony and many other elements and organic materials, which have subsequently been taught to play their roles in the vast modern telephone system; but until the matter of how to utilize them in the design and construction of such apparatus as cables, loading coils, repeaters and switchboards had been searched out, these substances were as far removed from practically useful telephonic apparatus as the words in the dictionary are remote from our classics of literature. The possibilities were latent; the human mind had not yet conceived them. And the touch of the artist was needed to search out the matter.

There were three ways in which the telephonic art in all its various phases might have been developed to meet operating needs. Each Associated Operating Company of the Bell System, acting by itself, through a large additional force of employees, and by retaining the services of physicists, chemists, mathematicians, metallurgists, designing engineers and other kinds of scientists and specialists, might have undertaken to develop its own methods, using its plant as an experimental laboratory (perhaps to the detriment of service to the telephone user) and to invent and design the new apparatus constantly required to meet the increasing and changing requirements of its business. Not only was new apparatus needed, but also the best methods for planning the growth of the plant, for installing it, for handling the traffic and for conducting every branch of the business had to be determined by trial and experiment, worked out, developed and made practically applicable. The art of telephony has always been continuously in a state of change and improvement. So rapid has been its growth and so radical its changes that the devices and methods of one period have been incapable of meeting the needs of the next period. If this plan (each company for itself) had been followed, much duplication of effort would have resulted and coördination of plant and practices between companies would have been difficult.

A SECOND WAY would have been for each Associated Company to have done nothing to provide for its needs in respect of all these matters, hoping and trusting that there might always be someone, somewhere, who would be in a position to sell to it something that it could use in some way. Had this plan been followed, such improvements as came would have had to await the successful efforts of those outside the business of supplying telephone service and, consequently, less familiar with its demands and requirements than those more intimately connected with it.

The third way was for the Associated Operating Companies to employ a centralized organization, working all the time for all of them, to per-

form all of those things which could most effectively and efficiently be done for all, in common, by such a central institution.

THE GREATEST CREDIT is due to the founders of the Bell System for their vision in selecting the last of these three ways. The merit of their choice is evident when the efficiency of telephone service and the extent of its use by the public in the United States is contrasted with that in other parts of the world. From the beginning this plan has been a most important factor contributing to the expansion and improvement of the Bell System. A remarkable continuity has characterized its pursuit of the search for advancement by means of invention and experimentation, ever becoming better and better coördinated, as the years have passed, by the application of added experience in organization and administrative methods.

In this work the world's store of general scientific knowledge has always been utilized to the full, but the fact stands out that the fruits of pure research in the various sciences rarely, if ever, admit of direct application in telephony. Skillful development work frequently requiring years of patient effort by highly trained engineers and specialized technical experts is needed before some general conception can be translated and crystallized into a definite, improved piece of apparatus, system or method capable of practical utilization in the working telephone system.

The enormous strides in all branches of the physical and other sciences that the first quarter of the present century has witnessed have had an important reaction on the methods

*The late Frederick L. Rhodes in 1927*

of conducting development and research work in the Bell System. In the early years, there was, literally, no profession of electrical engineering. Such knowledge of electrical theory as existed at that time was so incomplete and elementary that much of the experimentation and design could proceed only by "cut and try" methods.

FOR EXAMPLE, the production of an improved induction coil, in 1893, required a series of hundreds of experimental coils to be made, one after another, each differing slightly from the others and embodying the lessons learned from testing those which preceded it. Only in that way could such vital matters as the dimensions of the core and the best sizes of wire and numbers of turns for both primary and secondary windings be determined. At the present time, coil design has become much more nearly an exact science through the application

of the greater knowledge that now exists of the physical laws of electromagnetic induction and of the values of the various electrical and magnetic constants which are involved.

New views as to the composition and structure of the atom and increasing knowledge of the behavior of electrons whose very existence was unsuspected comparatively few years ago, are placing new tools in the hands of the mathematical physicists of the Bell Telephone Laboratories and the Department of Development and Research * of the American Company. To these modern scientific discoveries they, themselves, have made and are making important contributions for, in many instances, it is becoming necessary to advance the frontiers of pure science and to solve baffling problems in fundamental research in order to lay the foundations for further advances in telephony.

NO ONE can say with assurance what some of these advances will be. We only know that, when realized, they will contribute to a better and broader telephone service.

* Combined with the Laboratories in 1934.

## Who's Who & What's What

(*Continued from page 71*)

TERLY for January 1938 carried his contribution on the occasion of the twenty-fifth anniversary of the Plan.

AFTER THREE YEARS of service in the Navy as navigation instructor and navigation officer, JOHN H. PAGE joined the Ohio Bell Telephone Company in 1946 as a traffic assistant. Various assignments in that department were followed, in 1950, by transfer to the Public Relations Department, where he was editor of a news bulletin and then of the company's *Ohio Bell* magazine. Since 1952 he has been information manager—a post enabling him to garner both the facts and the impressions he sets down in his contribution to this issue.

STARTING WITH THE Ohio Bell Telephone Company in 1920, DONALD S. BRIDGMAN transferred to the A. T. & T. Company a year later. Since then, in the Personnel Relations Department, he has been concerned with technical and staff employment, and in recent years has been responsible for coördination of the college employment programs of the Bell System companies. He is interested in questions arising in connection with military service of Bell System people, and his activities include arranging for inspection and study of the Bell System by visitors from other countries who come here in connection with government programs. He participates actively in the work of organizations which concern themselves with the general problem of the country's professional and technical manpower. The present is Mr. Bridgman's fourth contribution to this MAGAZINE, his most recent previous one having been "Bell System Men and Women on Active Duty," in the issue for Summer 1951.

Reproduction of an original needle-point tapestry

# Woven into the Fabric of the Nation

Daily, as on a magic loom, the countless activities of millions of people are woven together by telephone.

Home is linked with home; business to business; community to community; city to city.

Friends and places nearby or far away are within the reach of a hand.

Without the telephone, time and space would rush between us, and each would be so much alone.

And so many things would not get done.